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**Stephan et al.**

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(54) **ONE-PIECE BONDING SPLICE FOR RAILS**

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**E04C 3/07** (2006.01)

**E04C 3/04** (2006.01)

(52) **U.S. Cl.**

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(58) **Field of Classification Search**

CPC ..... E04B 1/2403; E04B 2001/2457; E04B 2001/2415; E04B 2001/2433; E04B 2001/2448; E04C 3/07; E04C 2003/0417; E04C 2003/0439; E04C 2003/0473; H02S 20/00; H01R 25/162; F24S 25/65; Y02E 10/47; Y02E 10/50

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,159,758 A \* 7/1979 Courson ..... B66B 23/22  
198/335  
4,269,043 A \* 5/1981 Kizu ..... F16D 3/76  
464/83  
4,570,408 A \* 2/1986 Frascaroli ..... E04B 1/5831  
403/176

(Continued)

OTHER PUBLICATIONS

International Search Report and Written Opinion from the International Searching Authority, dated Mar. 30, 2021, 11 pages, for corresponding International Patent Application No. PCT/US2020/062406.

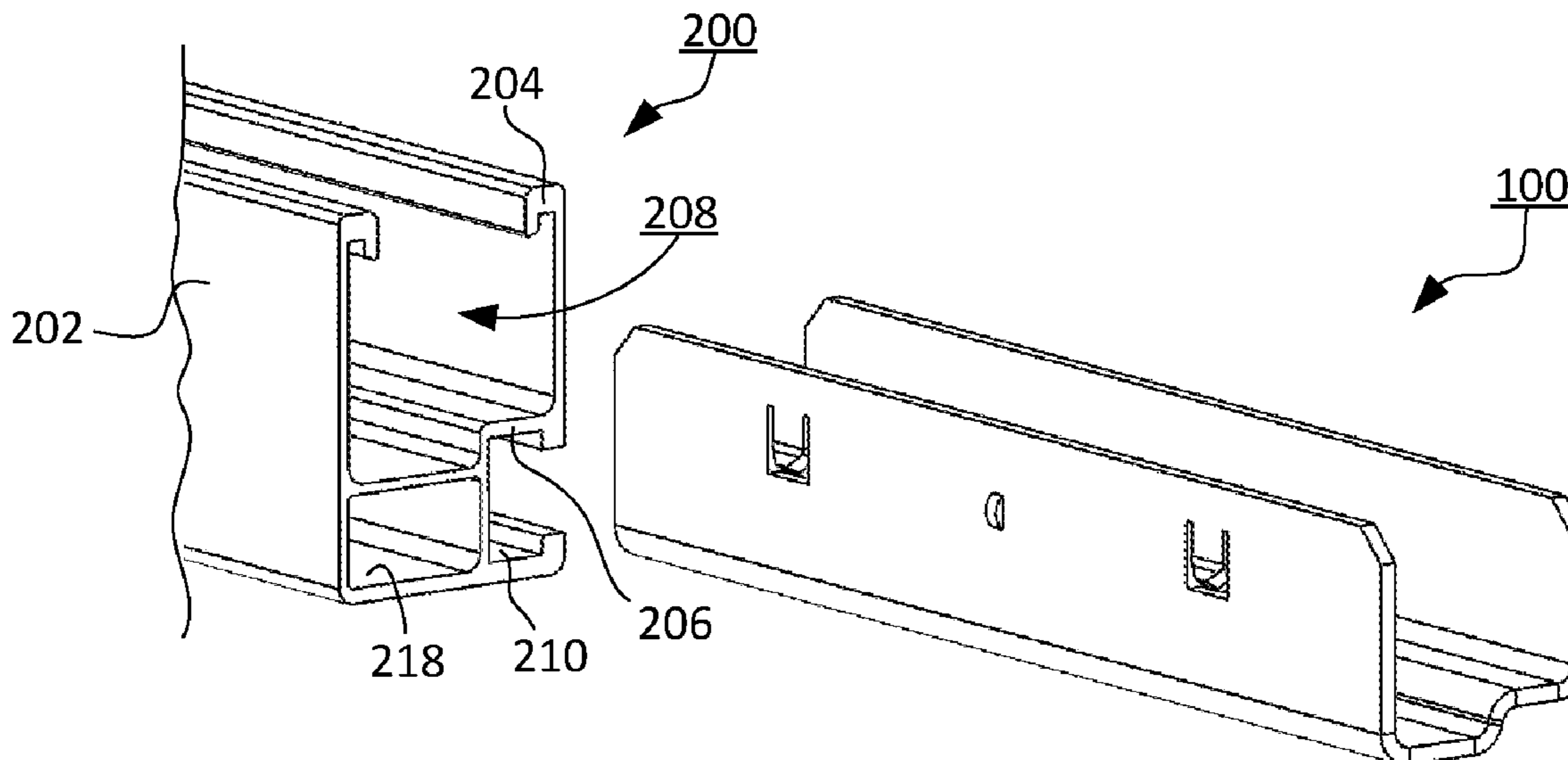
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(57) **ABSTRACT**

A splice having a main body and one or more protrusions extending from the main body. The one or more protrusions can be operable to interfere with a rail when the main body is installed into an opening of the rail. The one or more protrusions may be operable to cut into a coating of the rail and form an electrical connection between the rail and the main body.

**12 Claims, 13 Drawing Sheets**



(56)

References Cited

U.S. PATENT DOCUMENTS

4,950,841	A *	8/1990	Walker	.....	H01R 25/162 174/16.2
5,144,780	A *	9/1992	Gieling	.....	E04B 1/5831 135/114
5,203,135	A *	4/1993	Bastian	.....	F16B 7/0413 403/292
6,874,971	B2 *	4/2005	Albaugh	.....	F16B 2/04 403/297
7,832,180	B2 *	11/2010	Dolby	.....	E04B 2/96 52/848
7,866,098	B2 *	1/2011	Cinnamon	.....	F24S 25/67 52/173.3
8,695,290	B1 *	4/2014	Kim	.....	F24S 25/67 52/173.3
9,121,433	B1 *	9/2015	Bacon	.....	F16B 7/0446
9,590,405	B1 *	3/2017	Maurer	.....	H01R 25/145
9,590,406	B1 *	3/2017	Maurer	.....	H02G 5/007
9,705,299	B1 *	7/2017	Maurer	.....	H02G 5/007
9,837,954	B2 *	12/2017	Ash	.....	F24S 25/65
2010/0281793	A1	11/2010	McPheeters et al.		
2011/0194886	A1 *	8/2011	Wu	.....	E06B 3/9681 403/23
2011/0240101	A1	10/2011	Sagayama et al.		
2014/0026946	A1	1/2014	West et al.		
2014/0165499	A1 *	6/2014	Vanker	.....	E04C 3/07 52/834
2015/0180404	A1	6/2015	Braunstein et al.		
2015/0226246	A1	8/2015	Kirchner		
2015/0357773	A1 *	12/2015	Schirmeier	.....	B60M 1/346 439/121
2016/0156169	A1 *	6/2016	Jaena	.....	H02G 5/007 439/213
2016/0329671	A1 *	11/2016	Kokenda	.....	H01R 25/145
2017/0063301	A1	3/2017	Ash		
2017/0201080	A1 *	7/2017	Maurer	.....	H02B 1/21
2017/0233996	A1 *	8/2017	Abernathy	.....	F16B 7/0446 52/698
2018/0094418	A1 *	4/2018	Winter	.....	E04B 1/5831
2018/0245331	A1 *	8/2018	Tang	.....	E04C 3/07
2019/0211543	A1 *	7/2019	Abernathy	.....	E04B 1/2403
2020/0056370	A1 *	2/2020	Hebiishi	.....	E04B 1/58
2020/0403559	A1 *	12/2020	Kresse	.....	H01L 31/042

\* cited by examiner

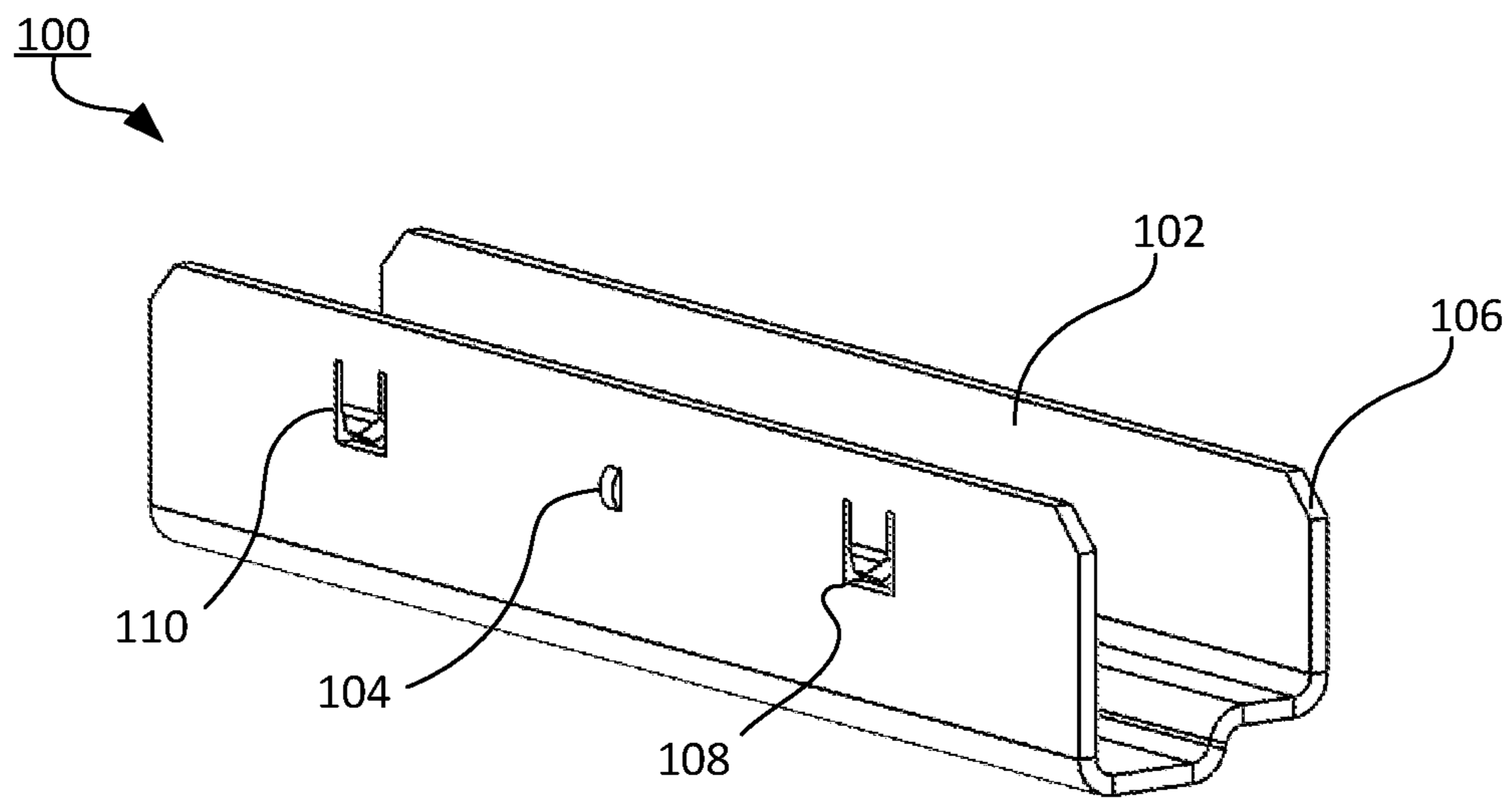


FIG. 1

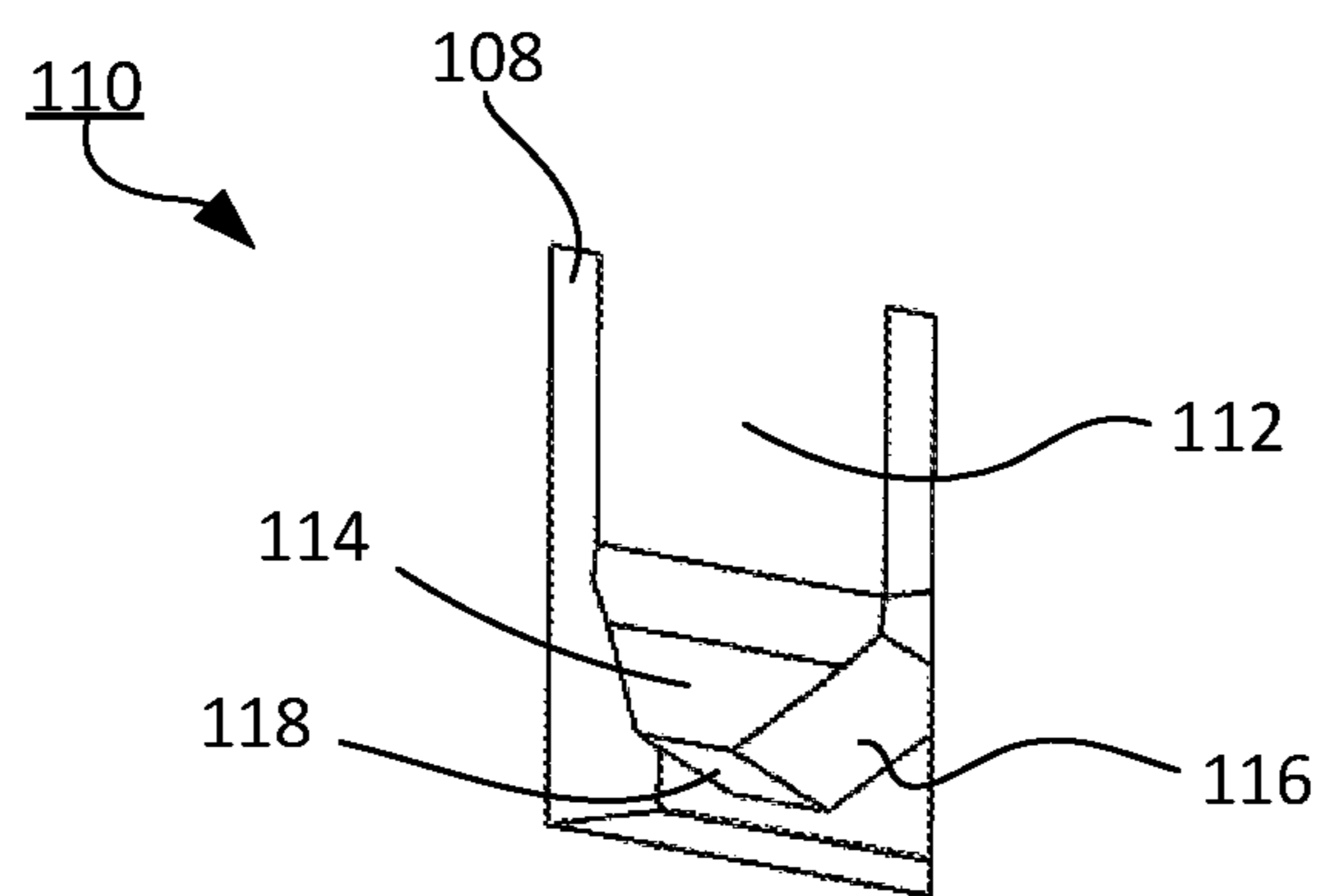


FIG. 2

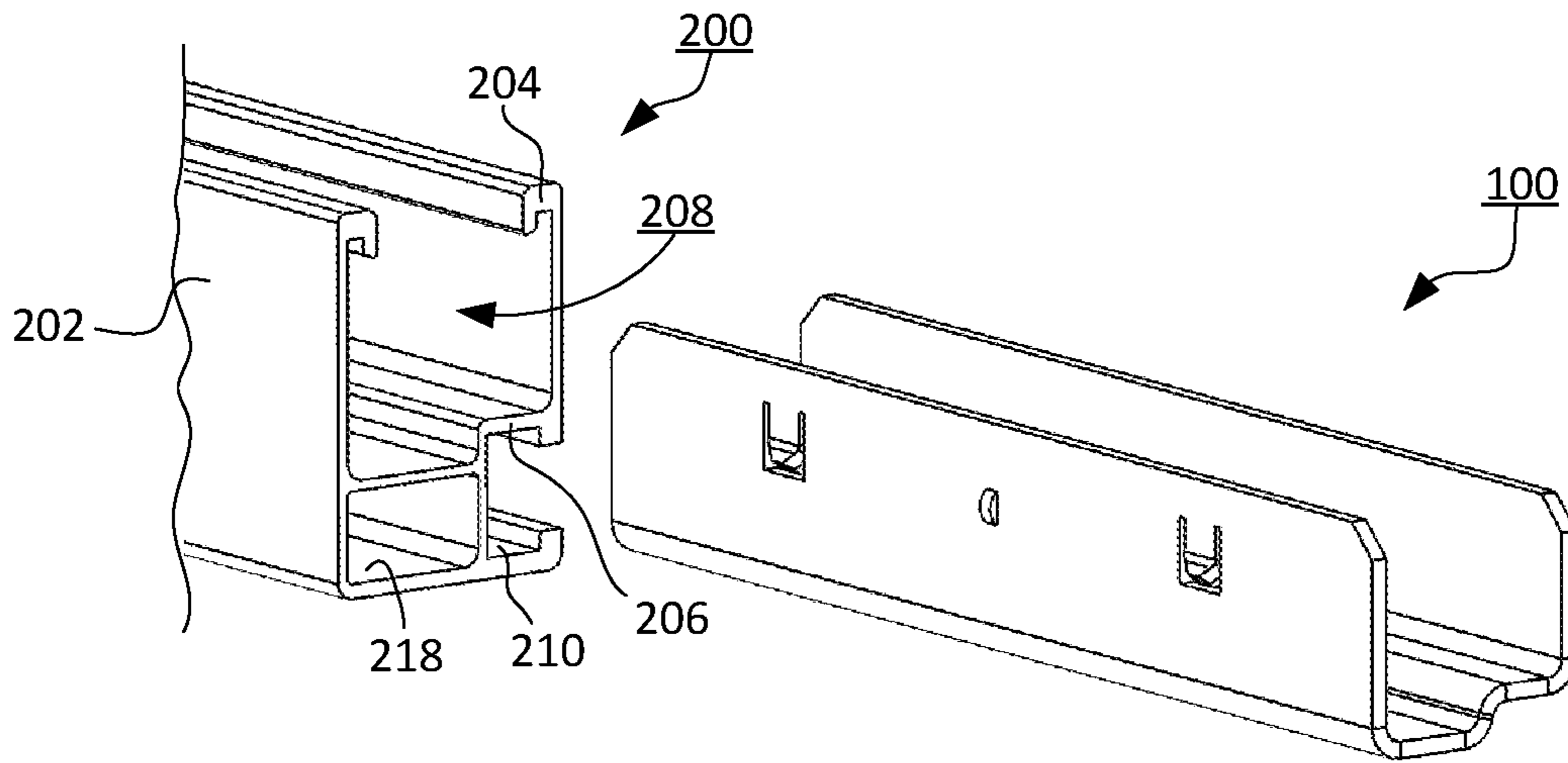


FIG. 3

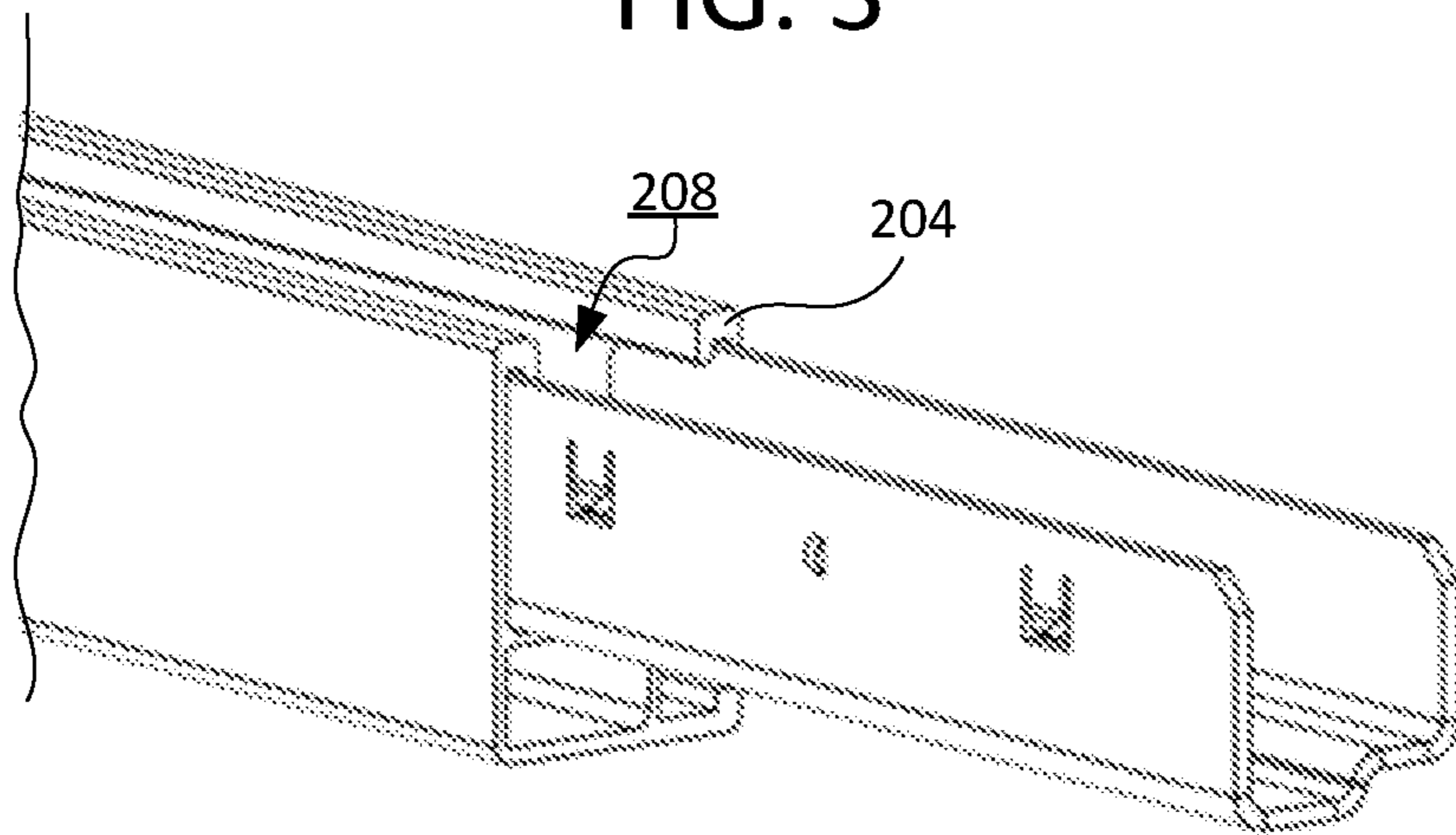


FIG. 4

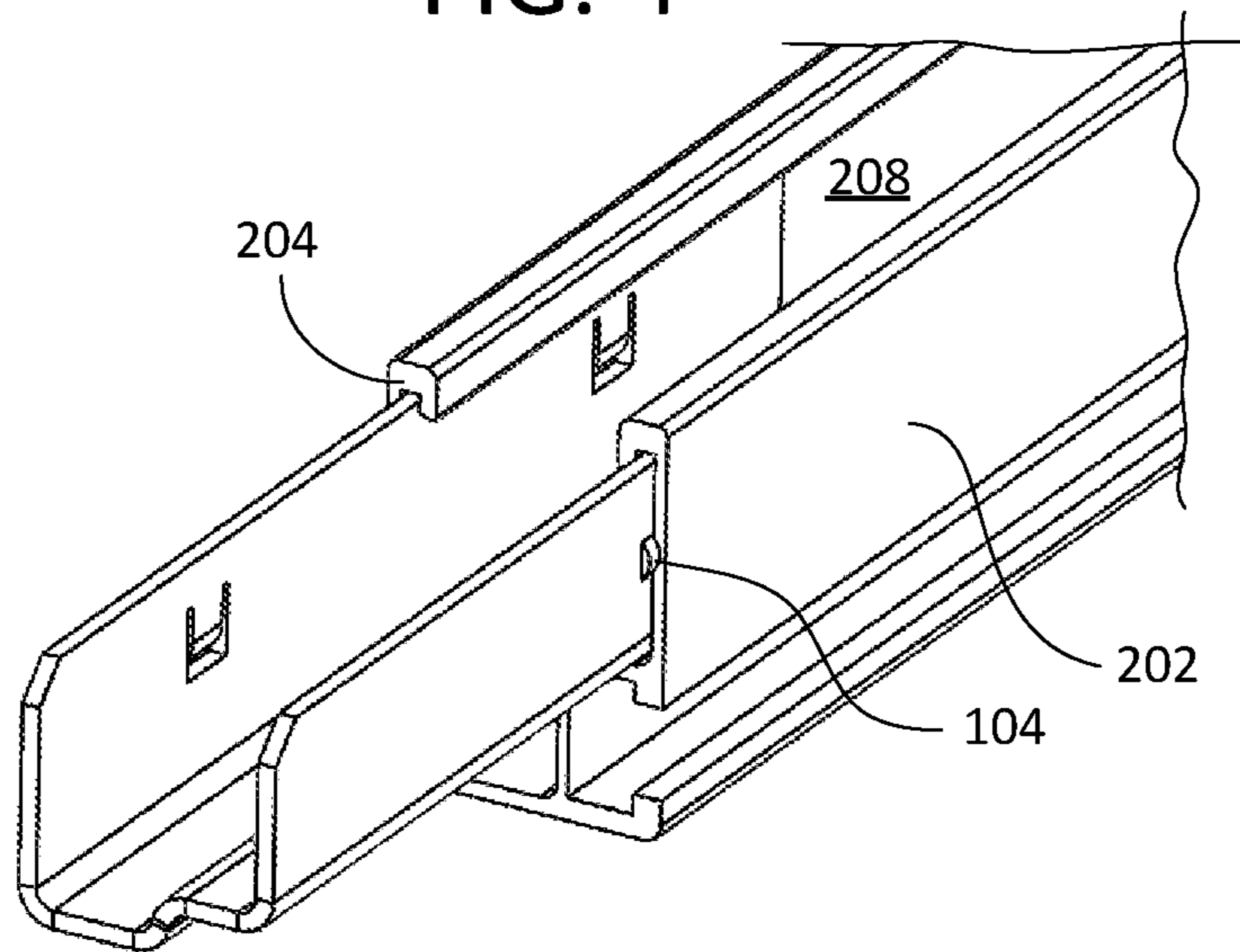


FIG. 5

FIG. 6

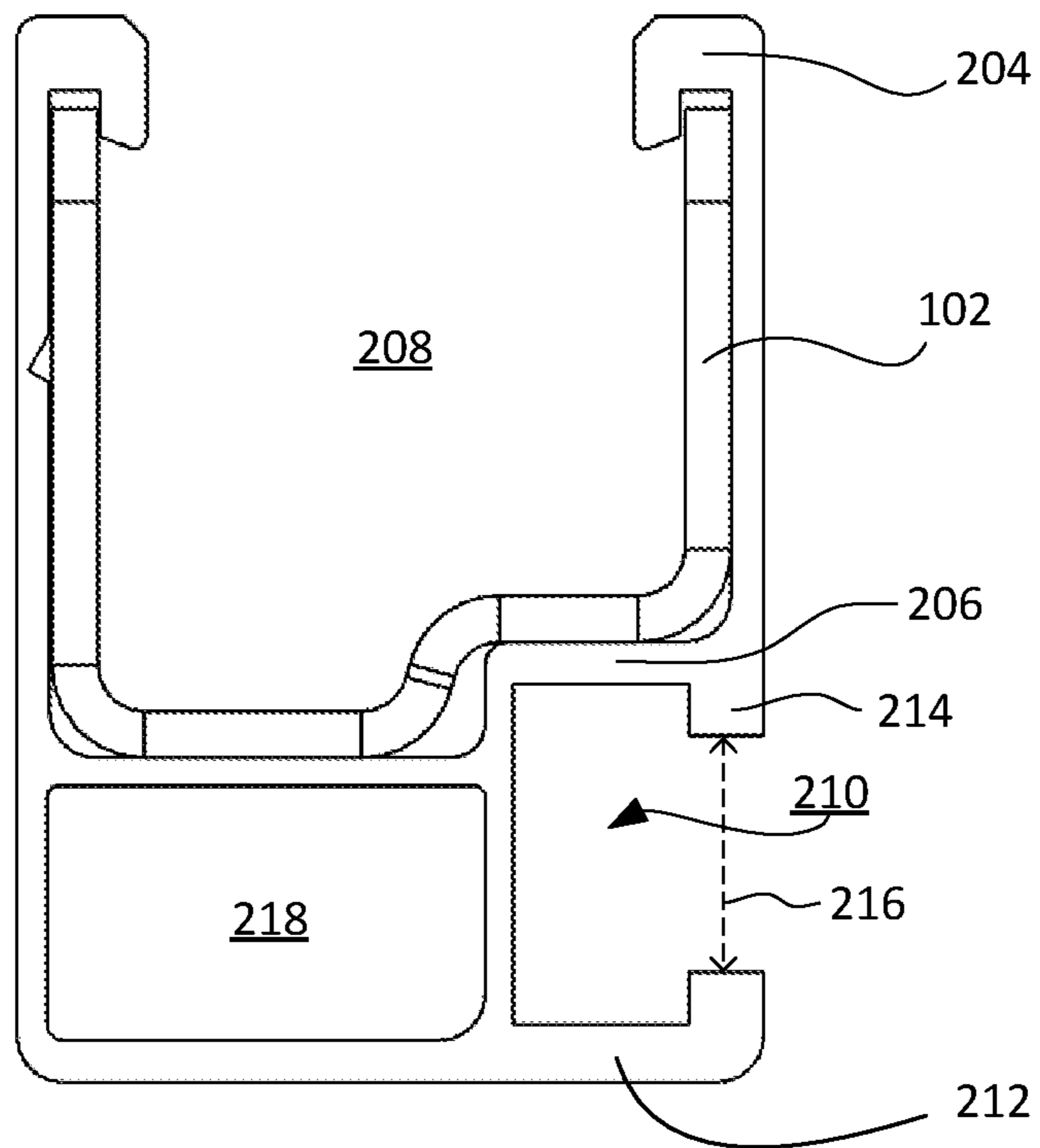


FIG. 7

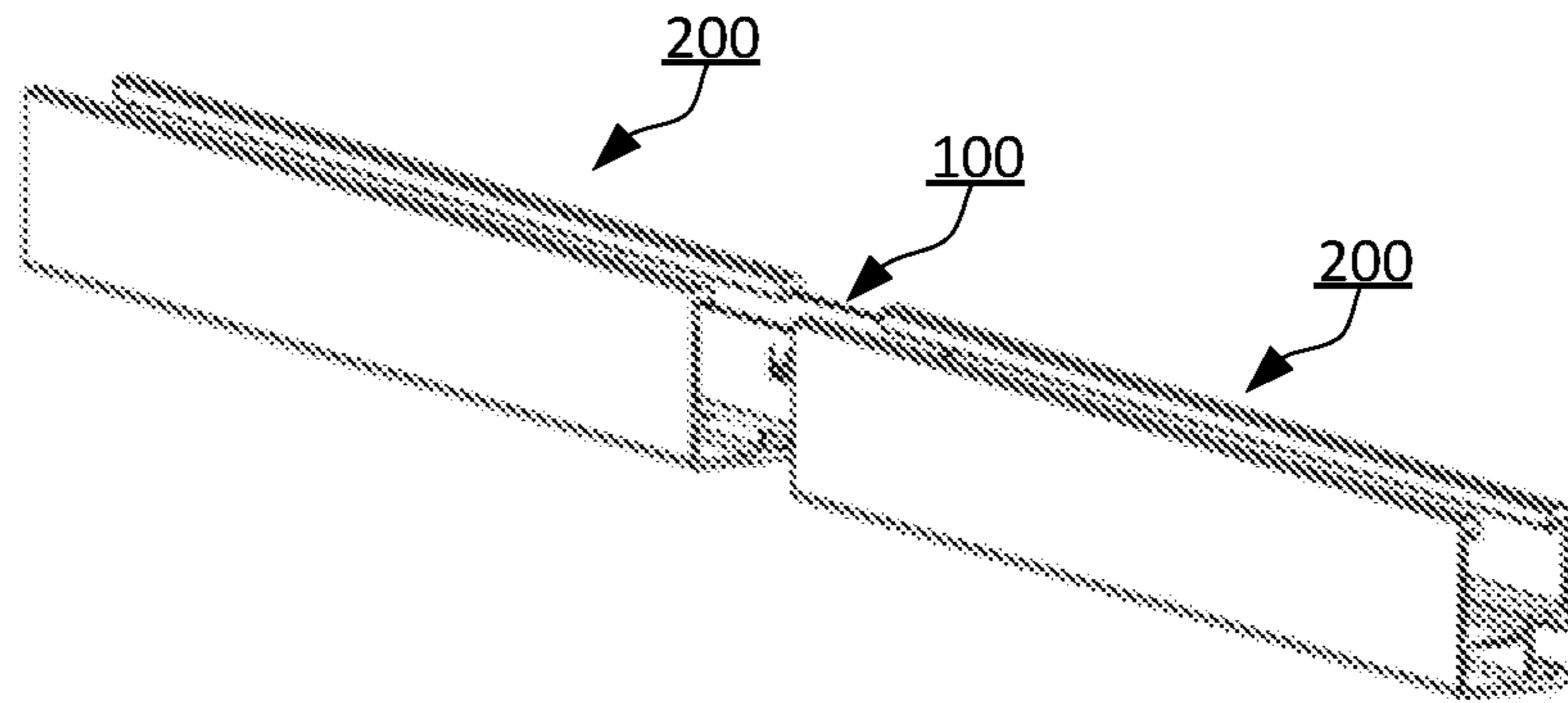
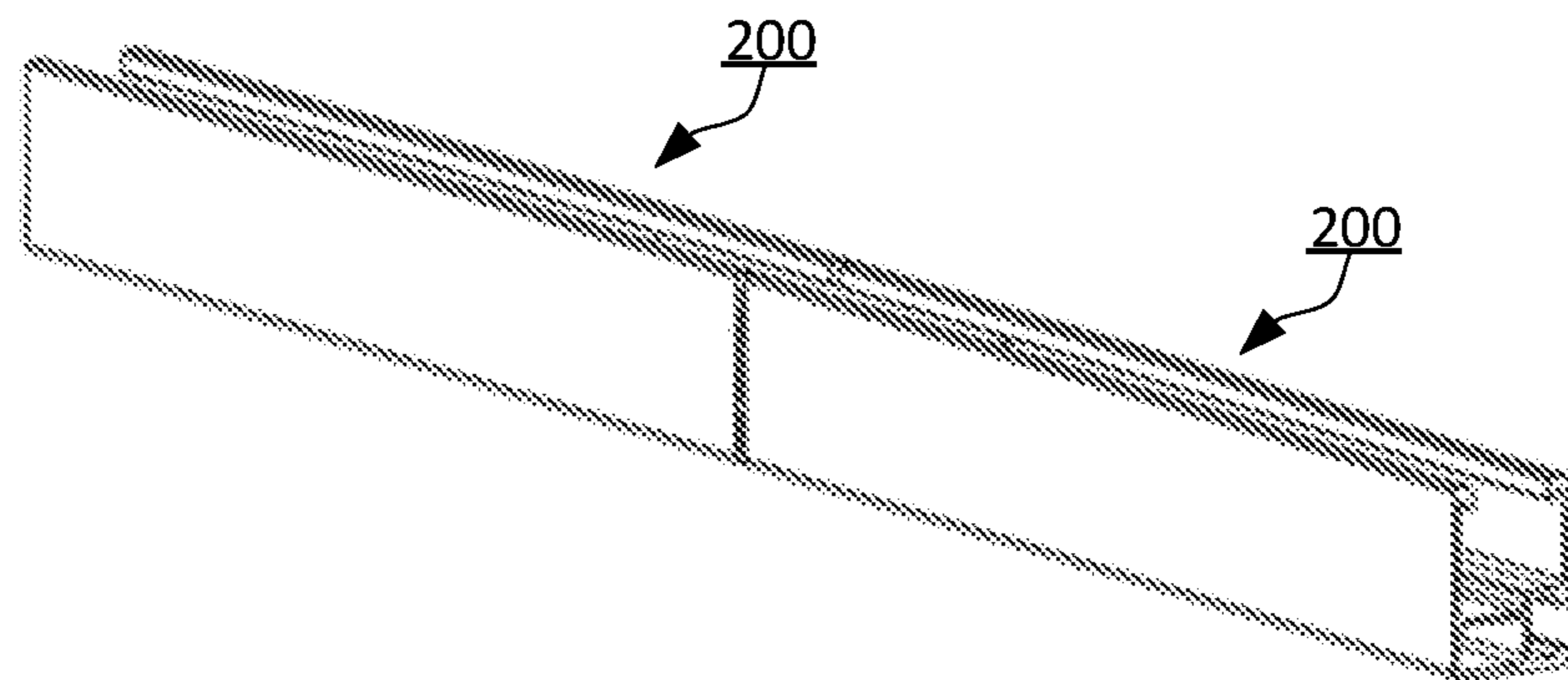


FIG. 8



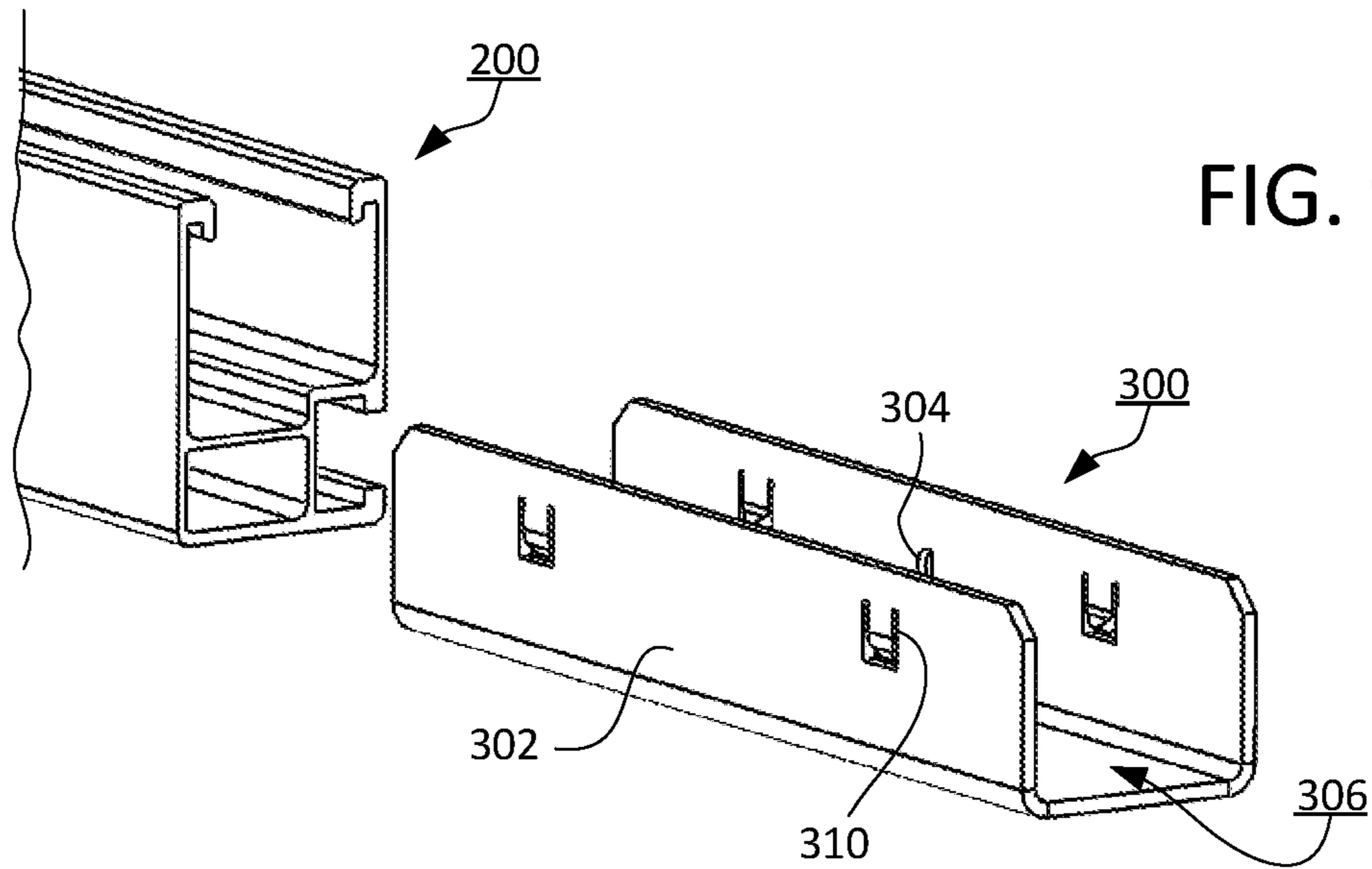


FIG. 9

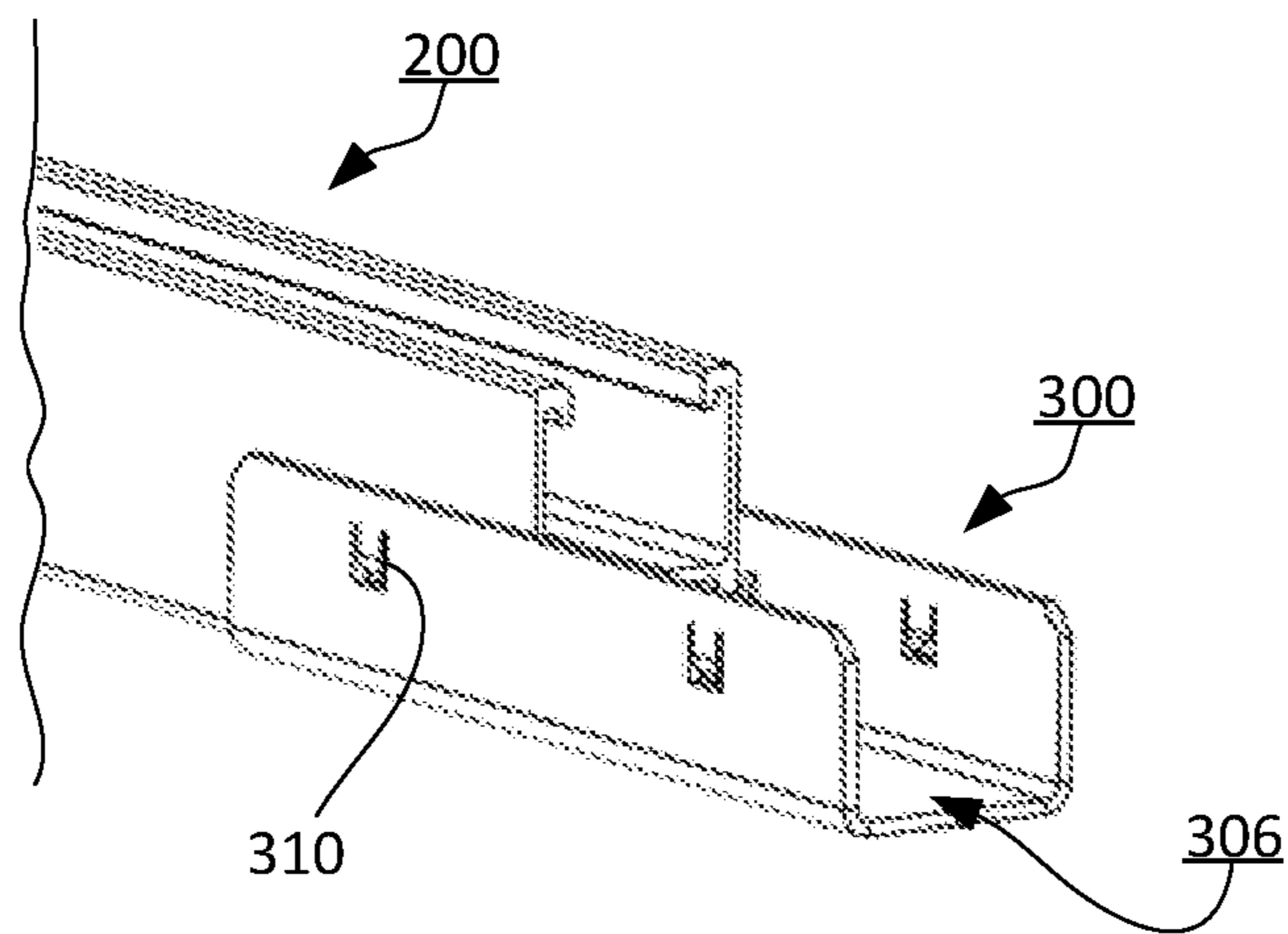


FIG. 10

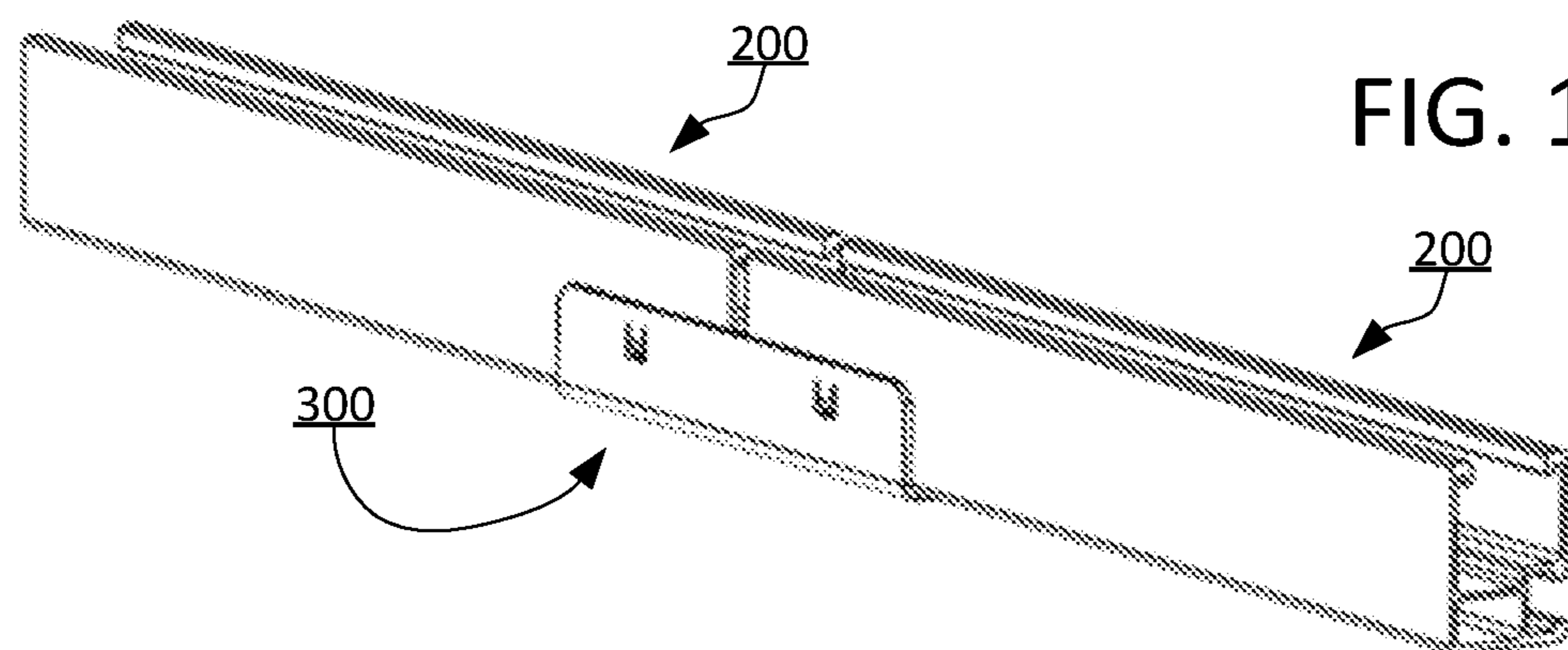


FIG. 11

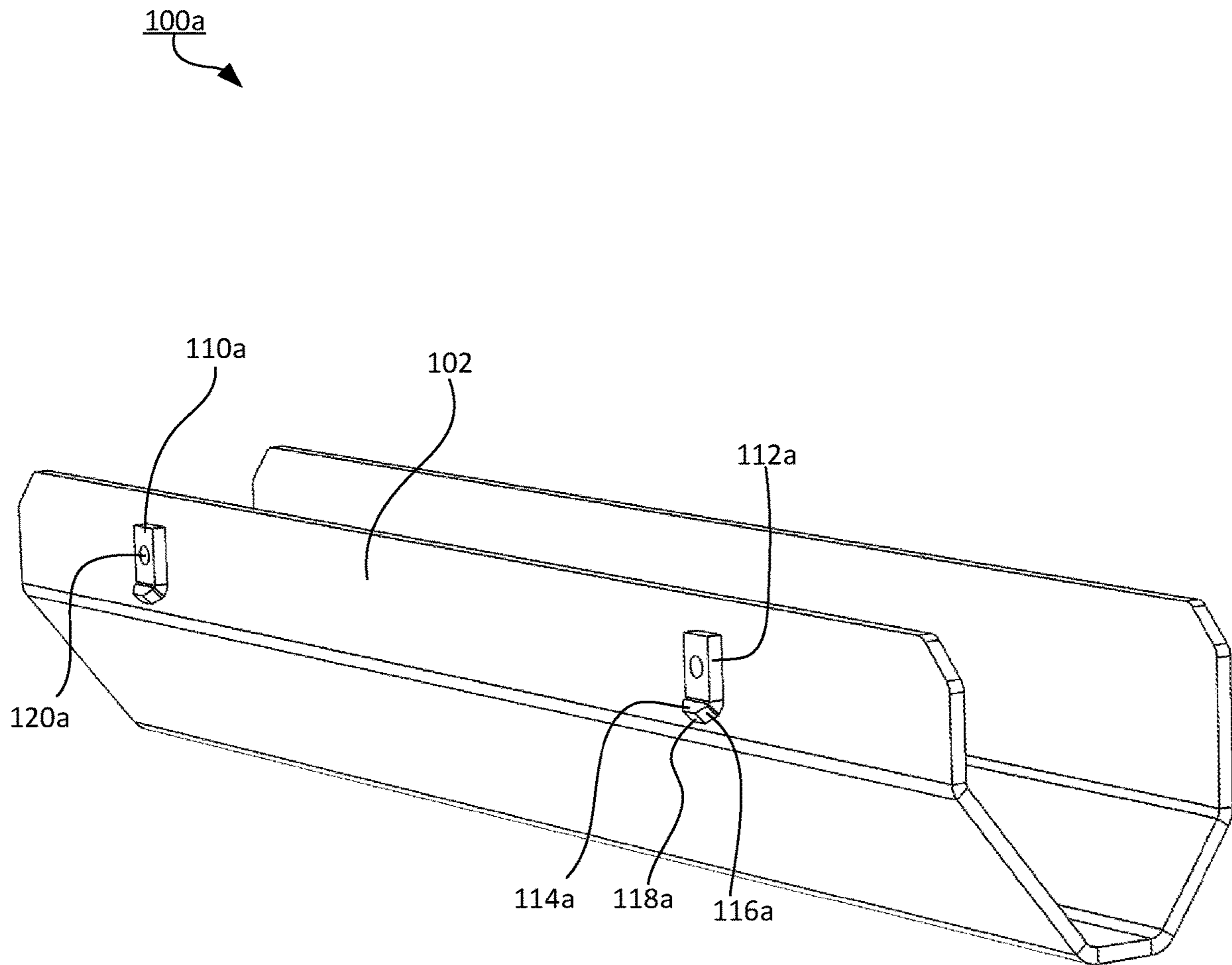


FIG. 12

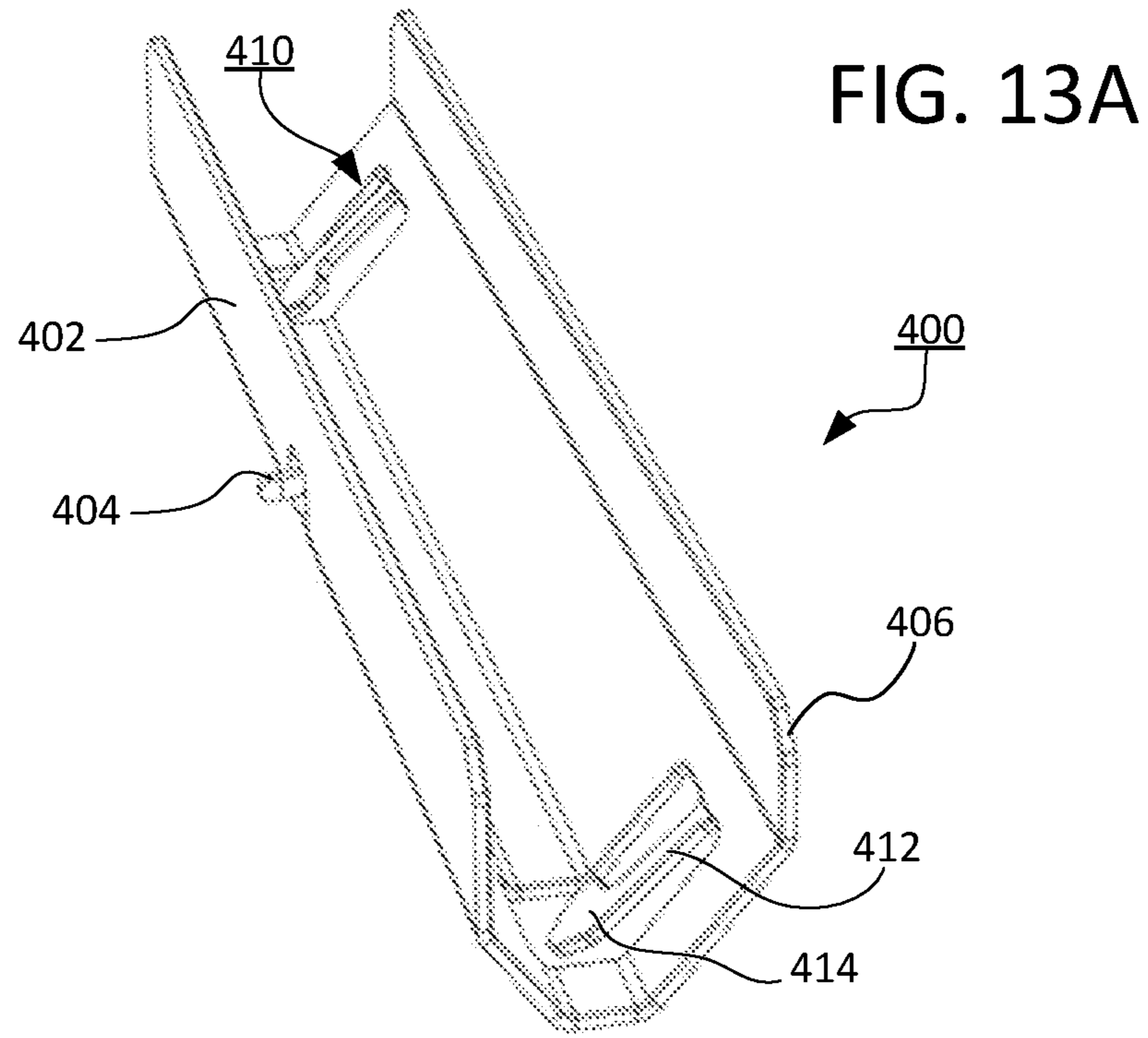


FIG. 13A

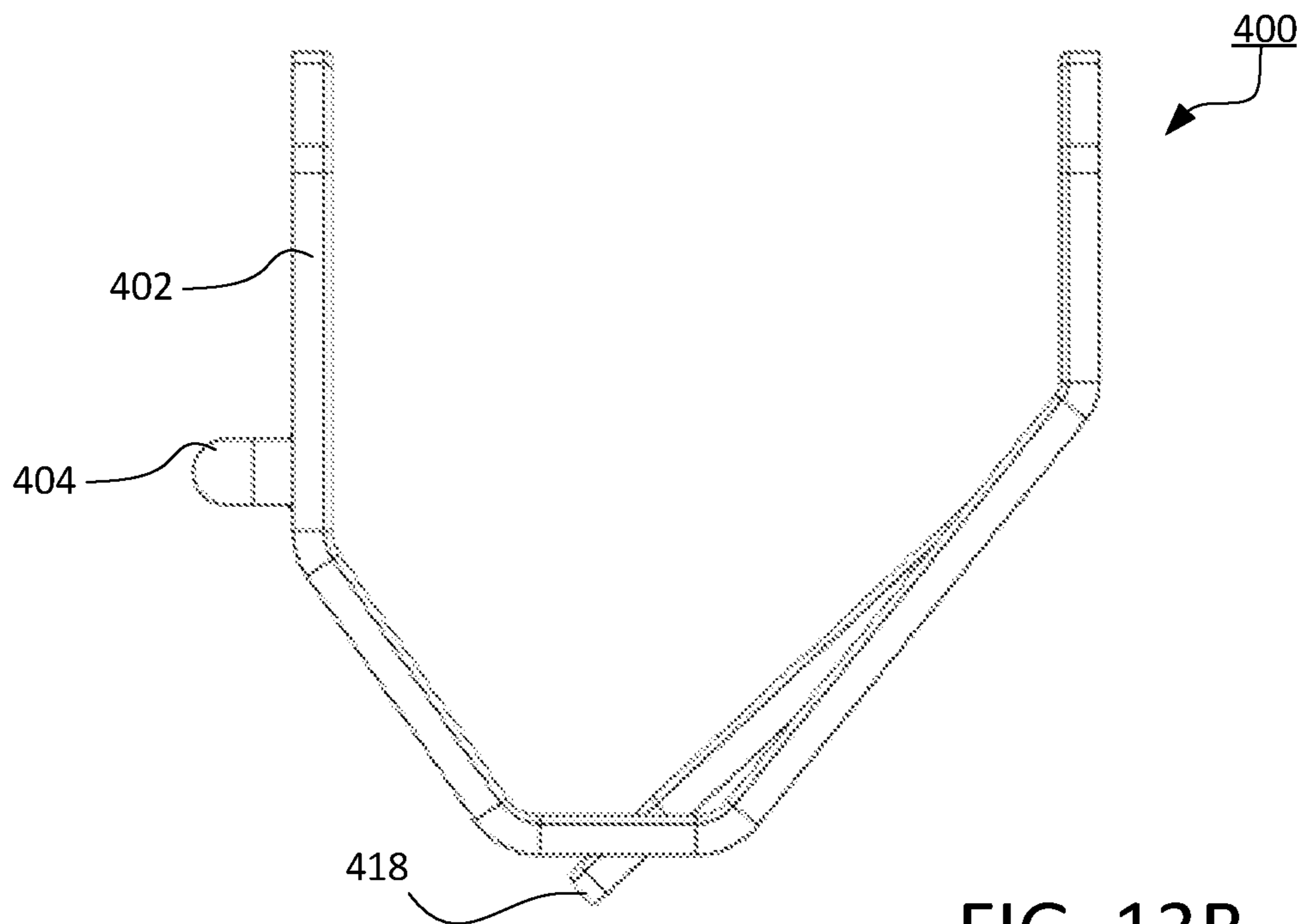


FIG. 13B



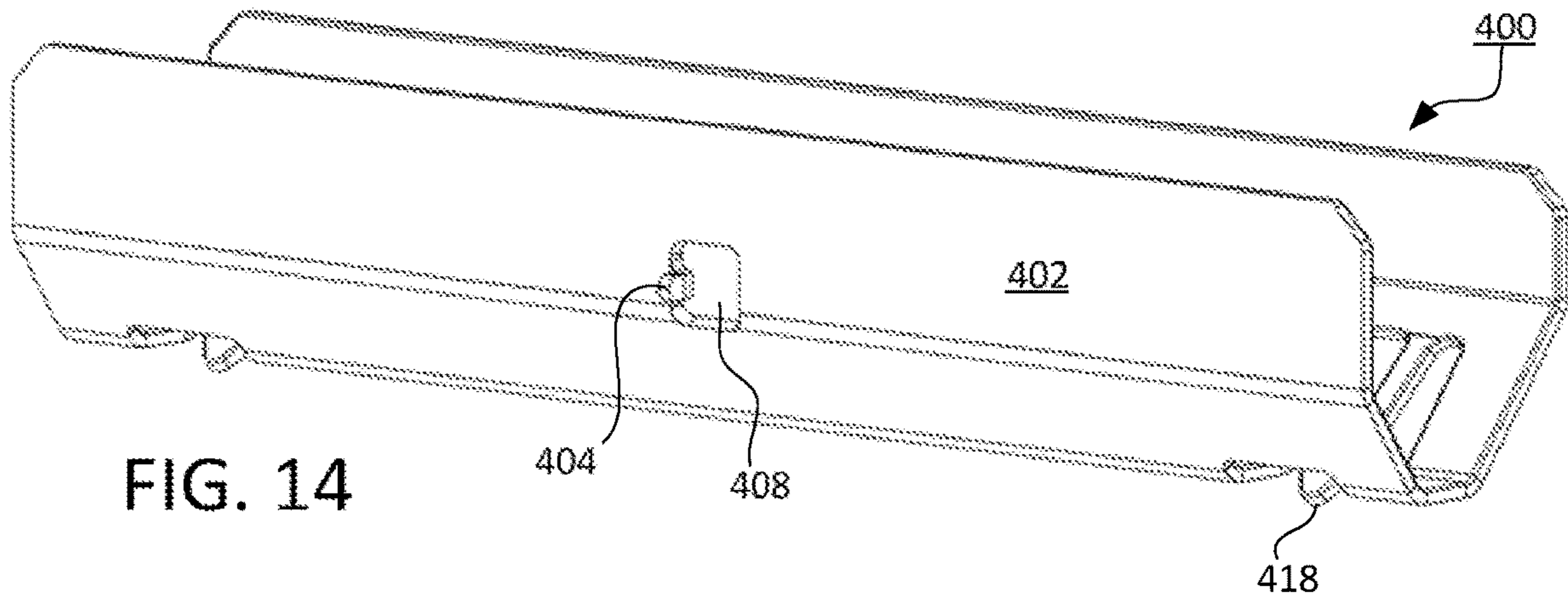


FIG. 14

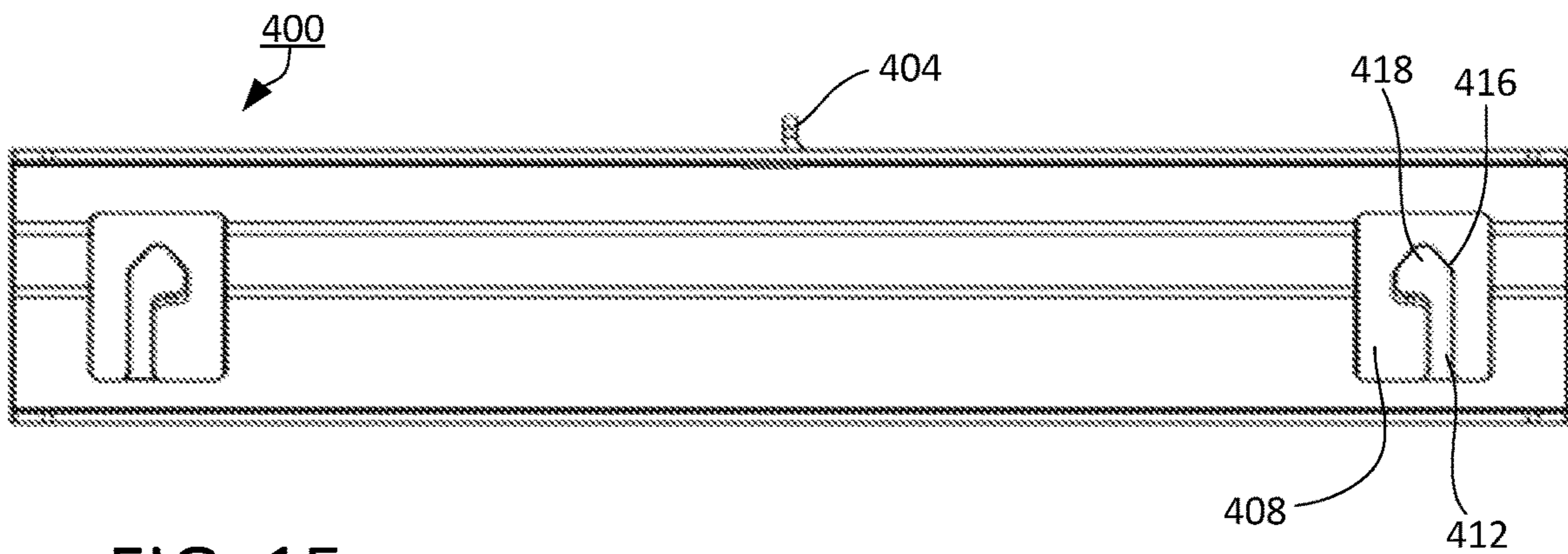


FIG. 15

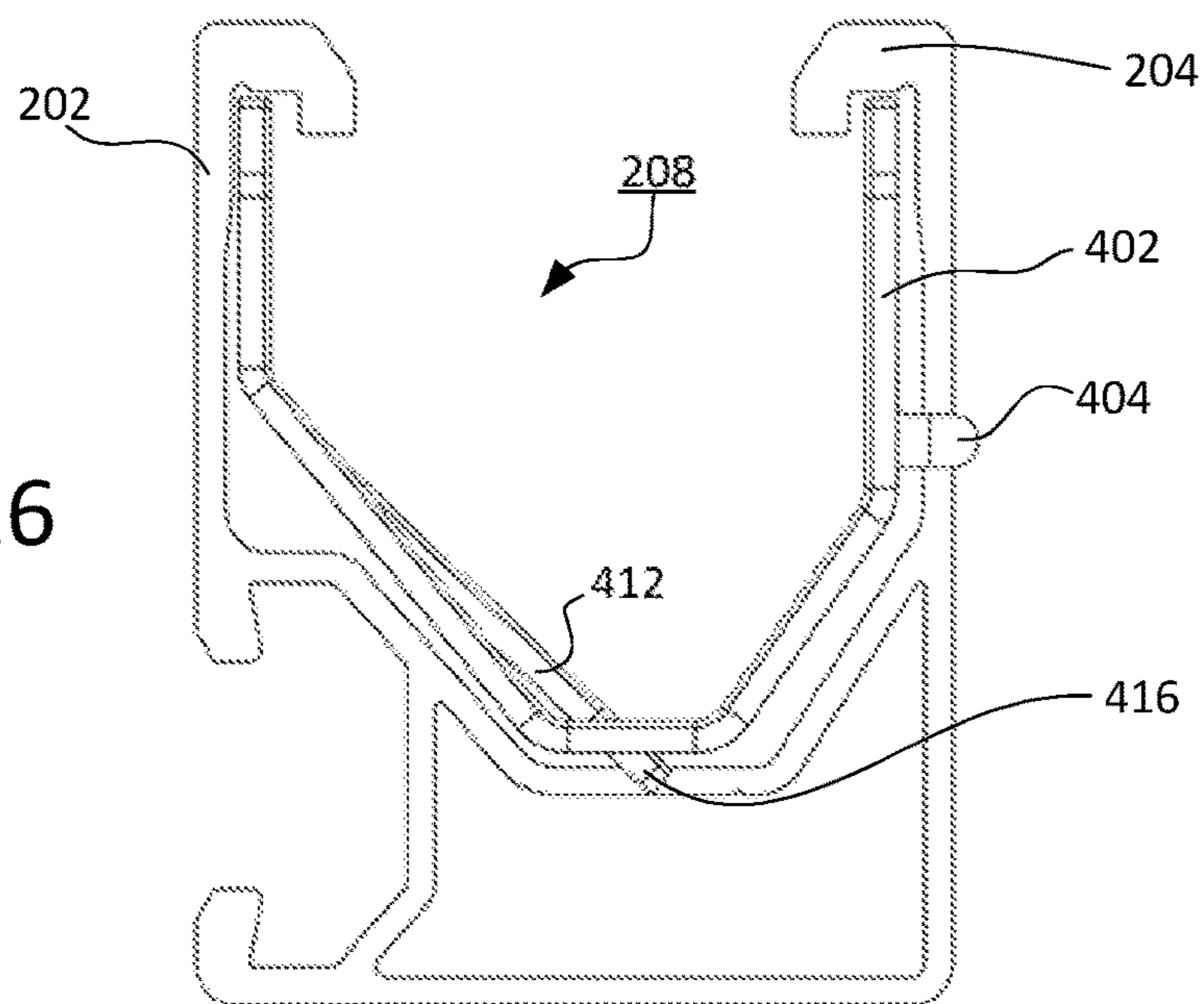


FIG. 16

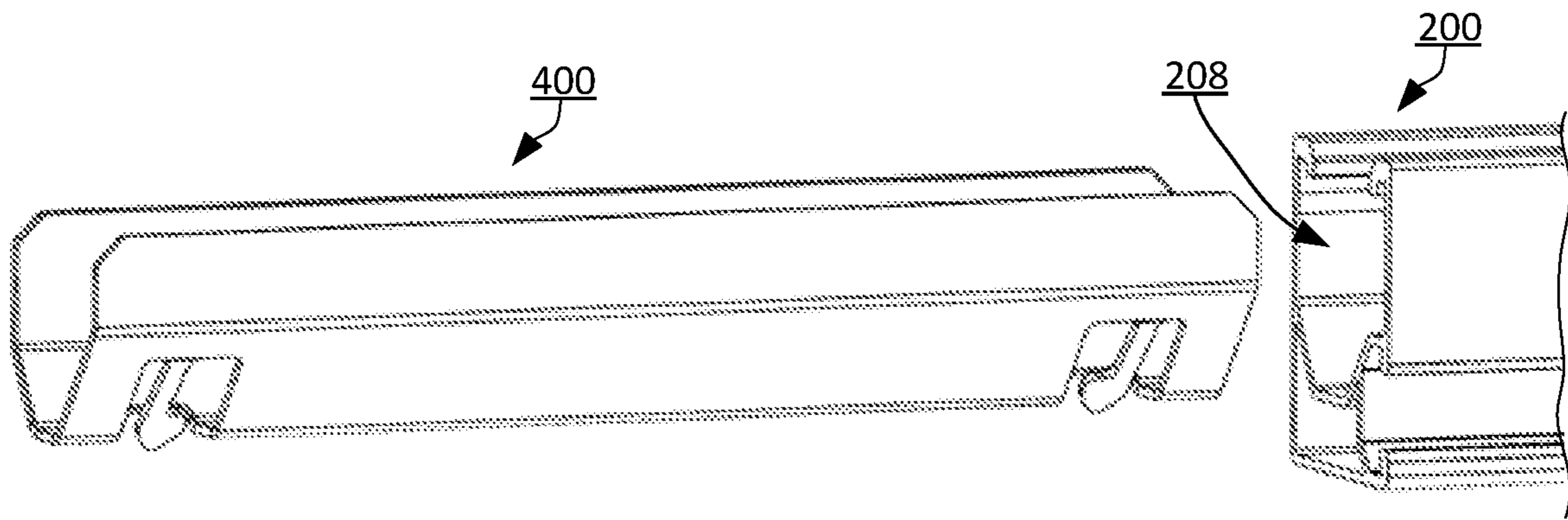


FIG. 17

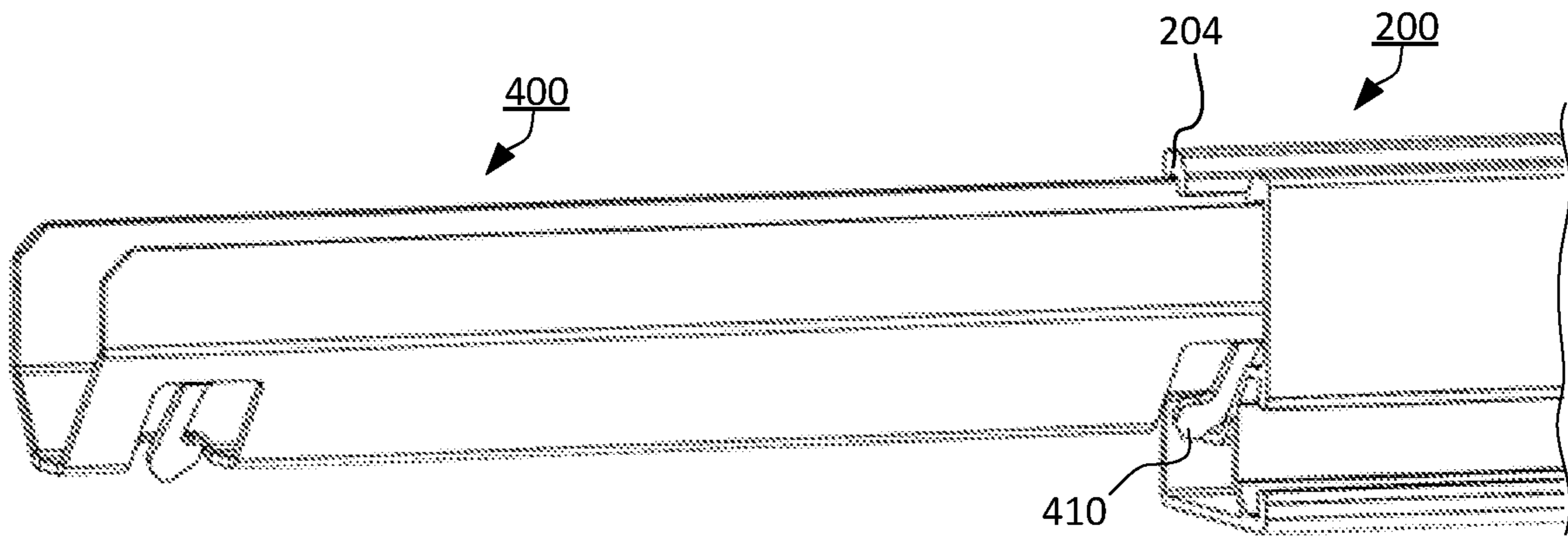


FIG. 18

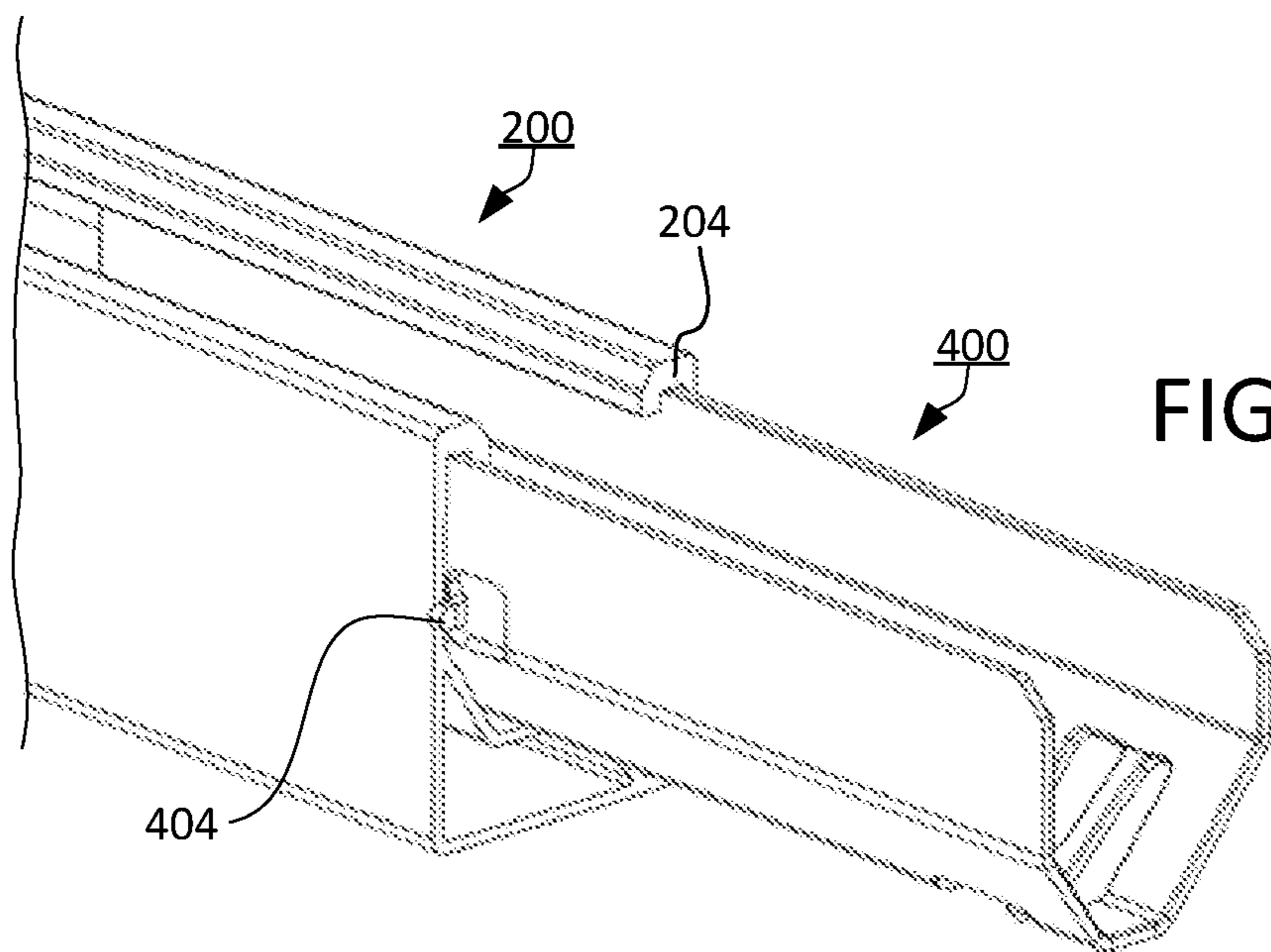


FIG. 19

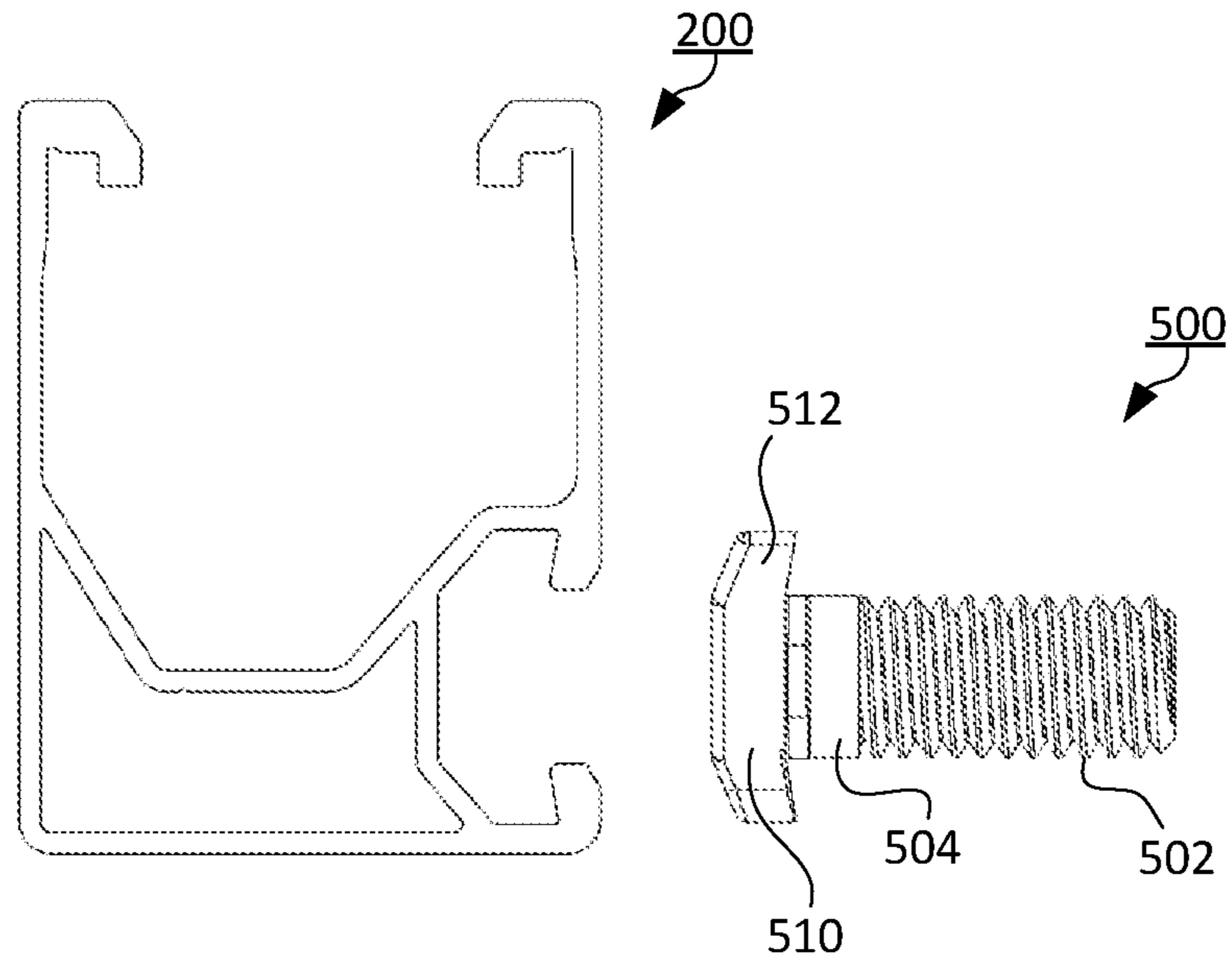


FIG. 20

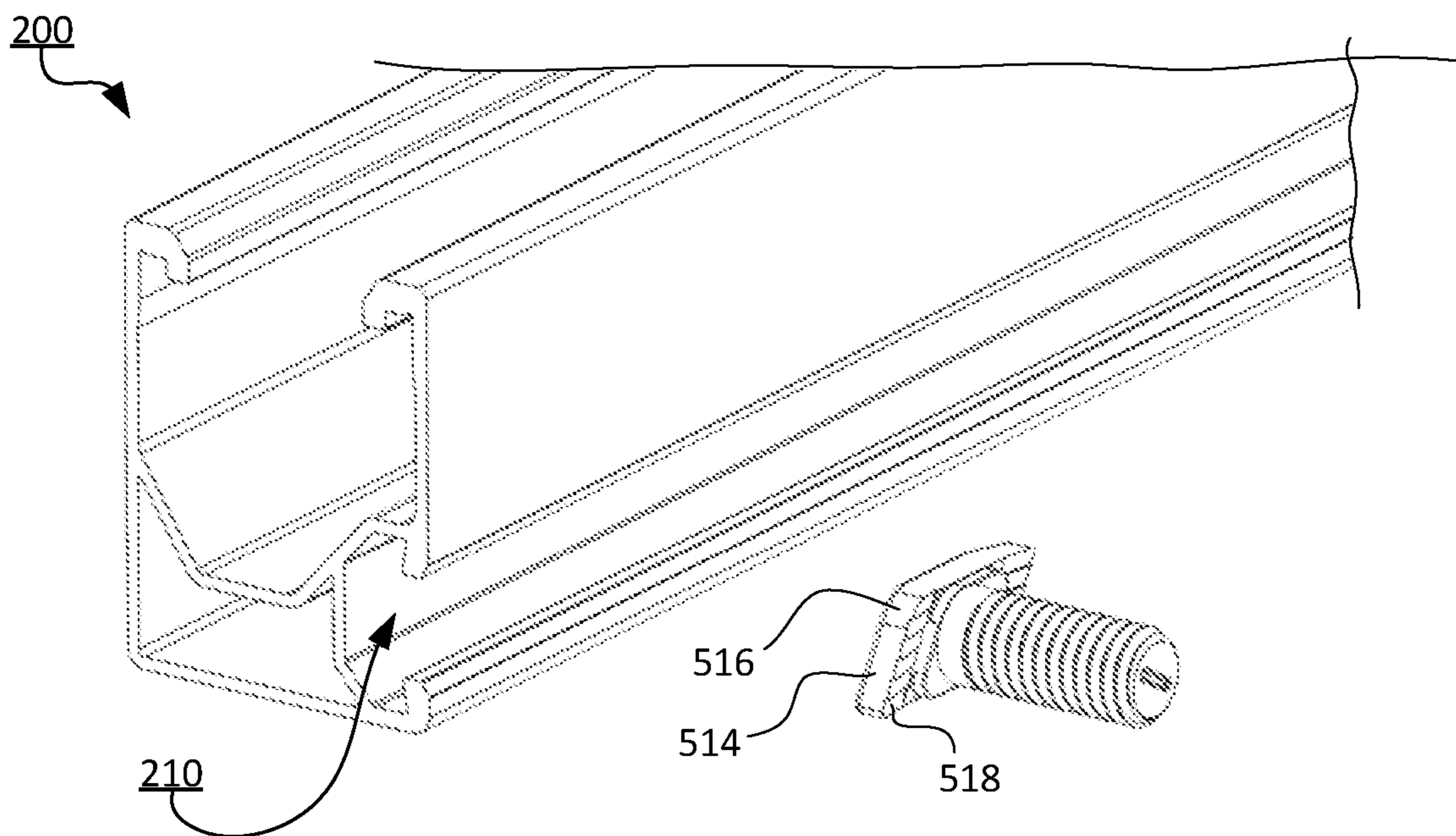


FIG. 21

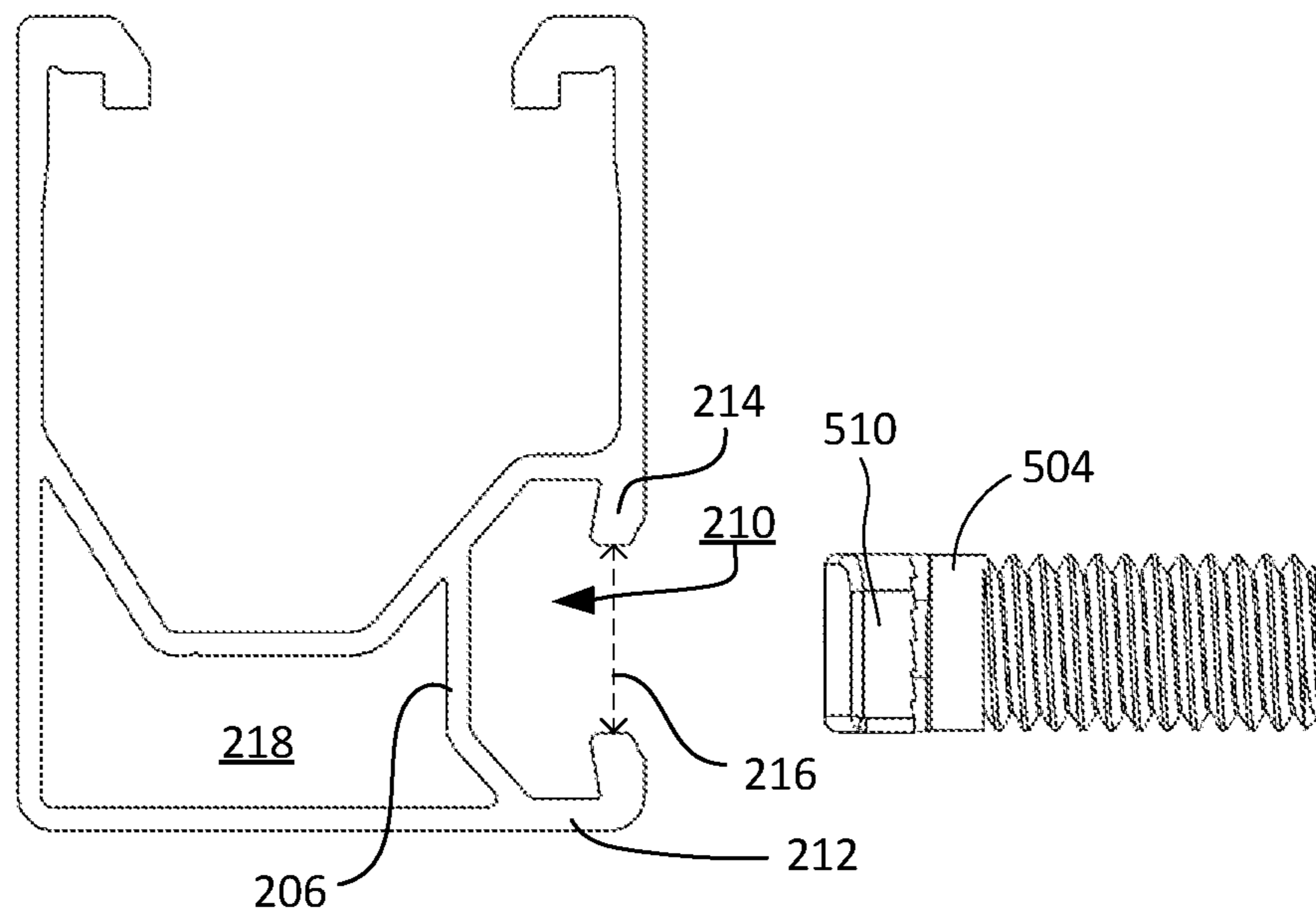


FIG. 22

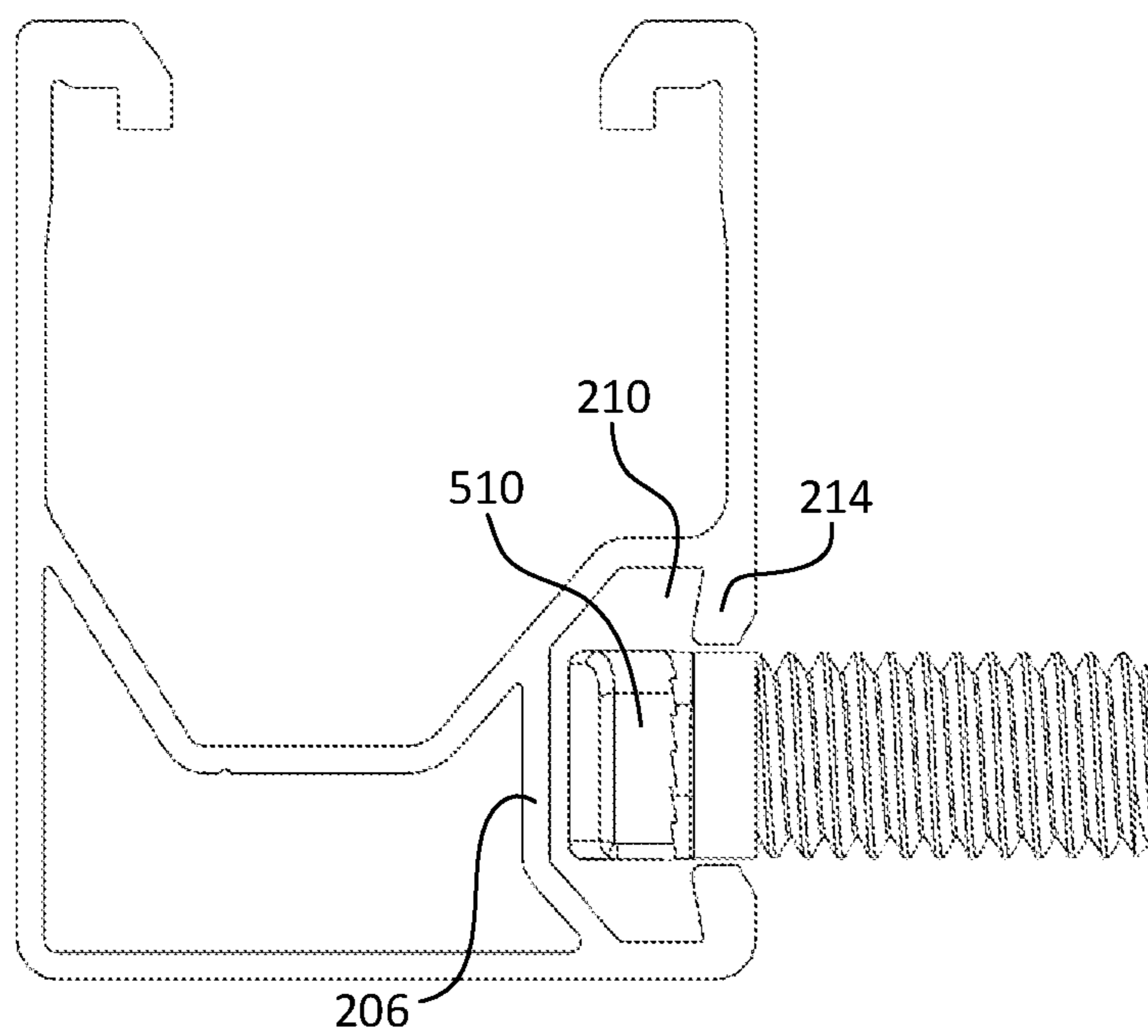


FIG. 23

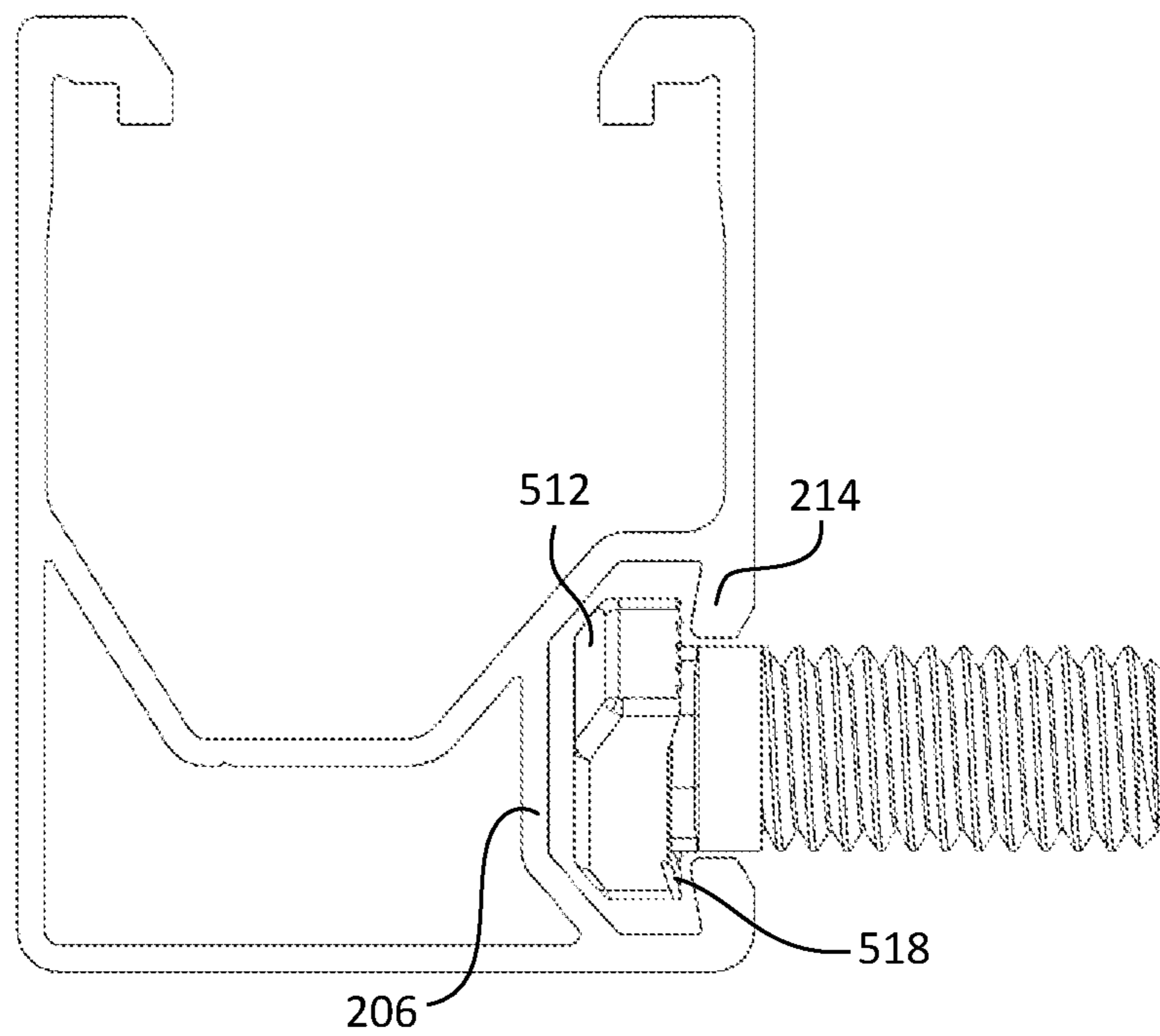


FIG. 24

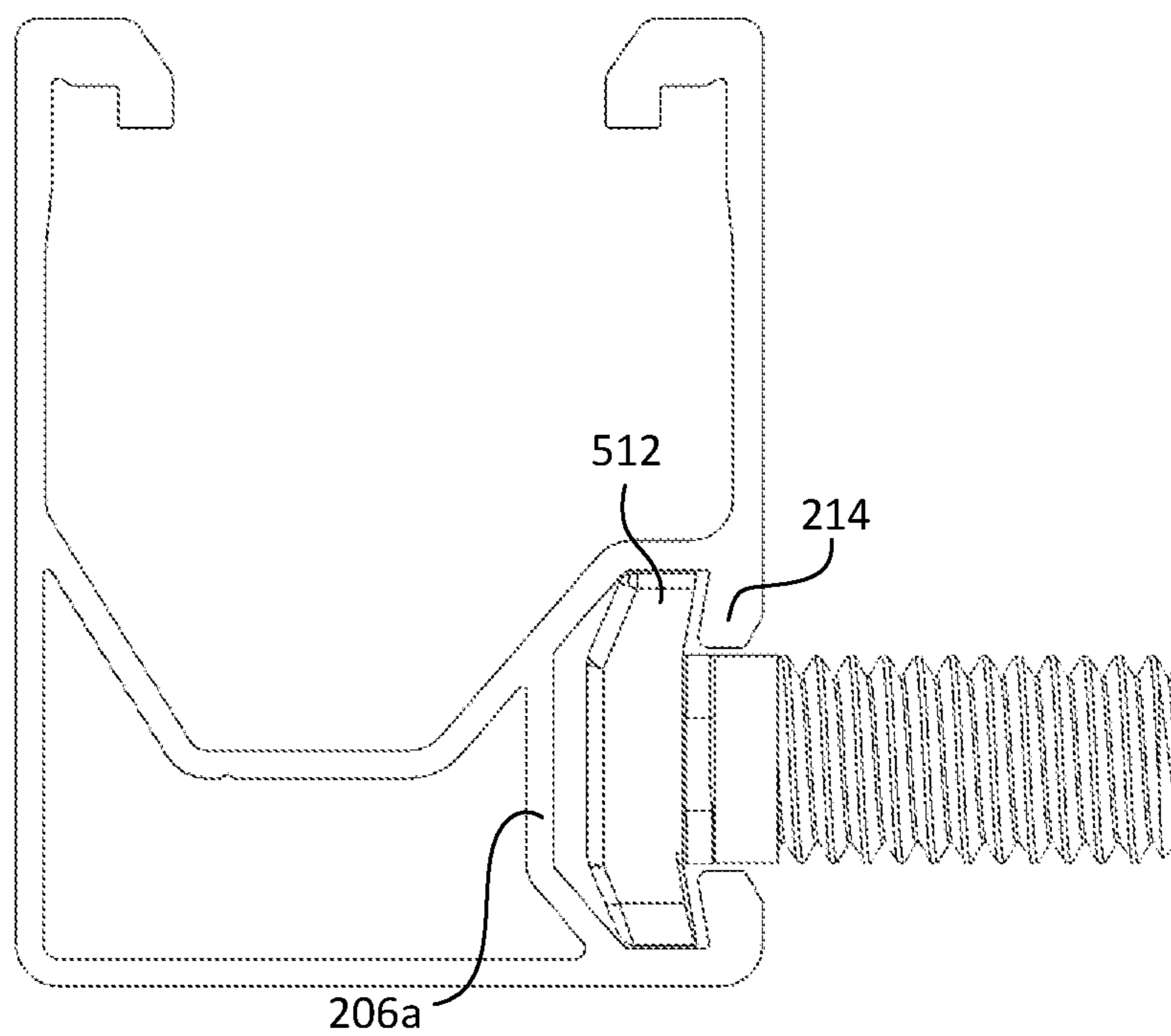


FIG. 25

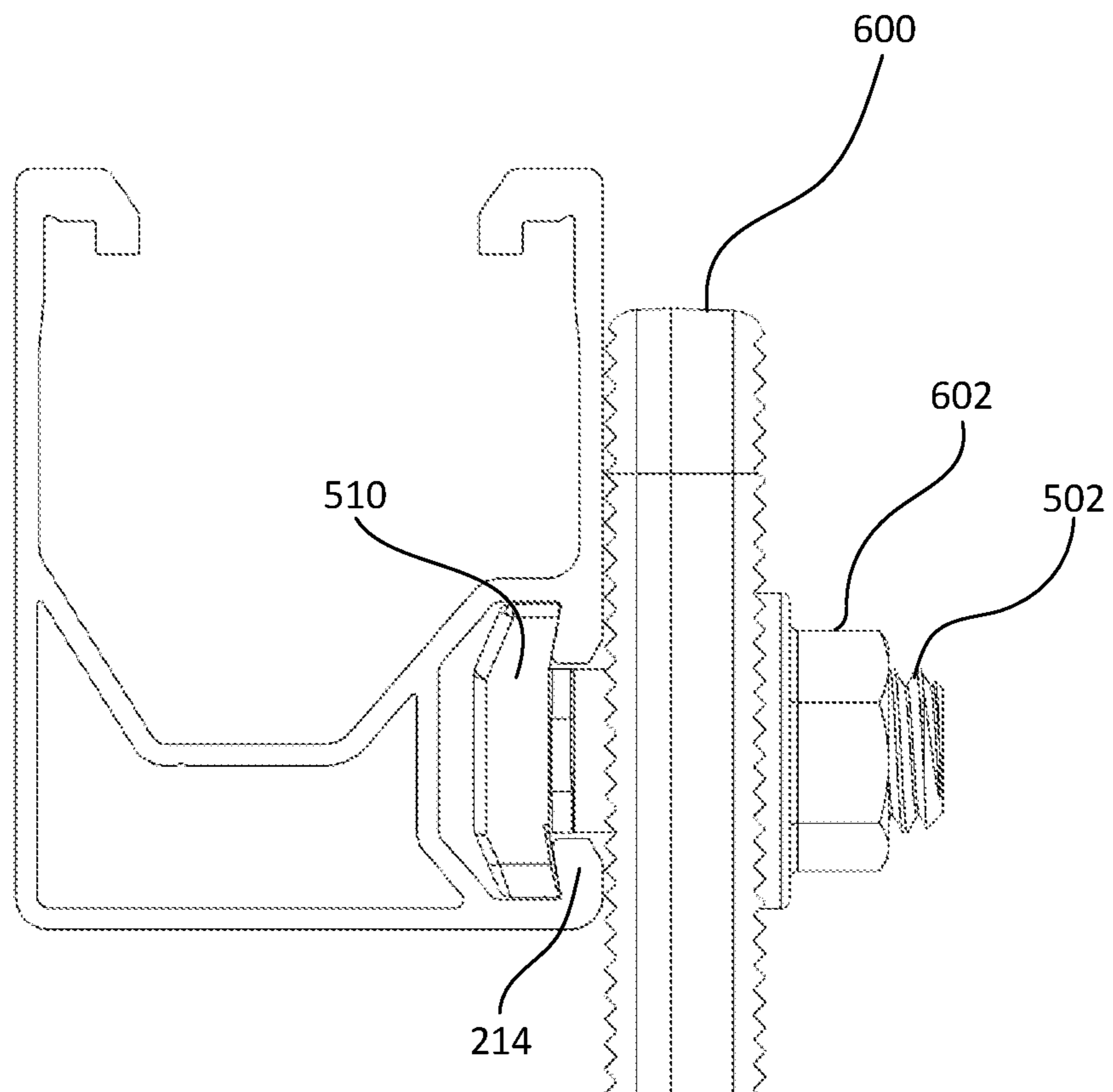


FIG. 26

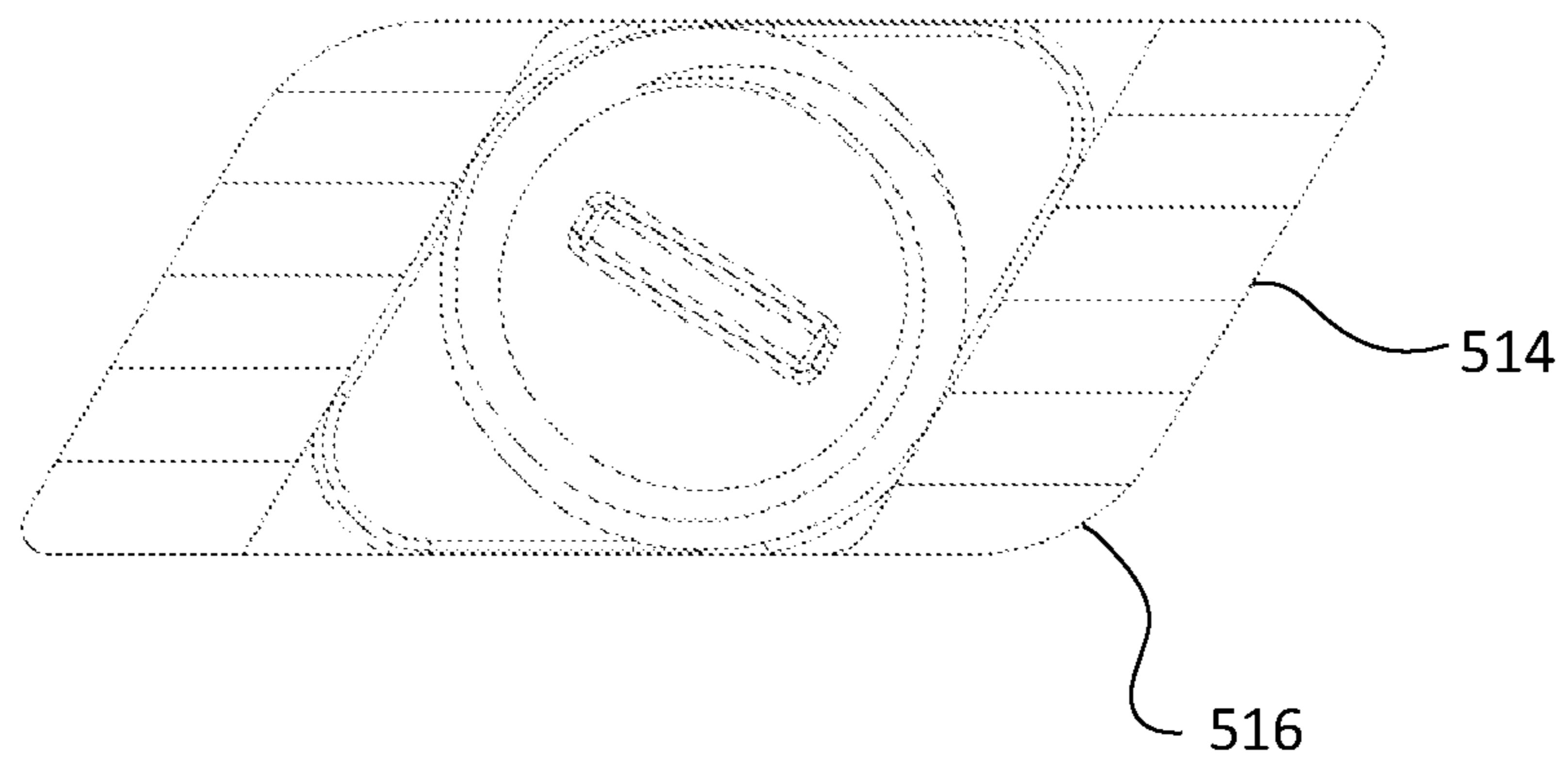


FIG. 27

**ONE-PIECE BONDING SPLICE FOR RAILS**CROSS-REFERENCE TO RELATED  
APPLICATION

This application claims the benefit of, and priority to, U.S. Provisional Patent Application No. 62/940,771, filed on Nov. 26, 2019, entitled "ONE-PIECE BONDING SPLICE FOR RAILS," the full disclosure of which is hereby expressly incorporated by reference in its entirety.

## BACKGROUND

Current solar mounting solutions using rails as mounting structure use one or more splices to connect rails together. Current splice designs typically require an assembly of components to mechanically secure and electrically bond splice to a rail section and to adjoin two rail sections together.

## BRIEF DESCRIPTION OF THE DRAWINGS

In order to describe the manner in which the above-recited and other advantages and features of the disclosure can be obtained, a more particular description of the principles briefly described above will be rendered by reference to specific embodiments thereof which are illustrated in the appended drawings. Understanding that these drawings depict only exemplary embodiments of the disclosure and are not therefore to be limiting of its scope, the principles herein are described and explained with additional specificity and detail through the use of the accompanying drawings in which:

FIG. 1 illustrates isometric views of a splice;

FIG. 2 illustrates a close-up isometric view of a bonding flange;

FIGS. 3-5 illustrate various steps of installation of a splice into a rail;

FIG. 6 illustrates an end-view of a splice installed into a rail;

FIGS. 7-8 illustrate various steps of installation of a second rail onto a splice;

FIGS. 9-11 illustrate various steps of installation of an example external splice with one or more rails;

FIG. 12 illustrates an upper perspective view of another example of a splice;

FIG. 13A illustrates an isometric view of another example of a splice;

FIG. 13B illustrates an end-view of the splice of FIG. 13A;

FIG. 14 illustrates an upper perspective side view of the splice of FIG. 13A;

FIG. 15 illustrates a top view of the splice of FIG. 13A;

FIG. 16 illustrates an end-view of the splice of FIG. 13A installed into another example rail;

FIGS. 17-19 illustrates various steps of installation of the splice of FIG. 13A installed into the example rail of FIG. 16;

FIG. 20 illustrates a fastener for the rail of FIG. 16;

FIG. 21 illustrates a perspective view of the fastener and the rail;

FIGS. 22-26 illustrate various steps of installation of the fastener into the rail; and

FIG. 27 illustrates a bottom view of the fastener.

## DETAILED DESCRIPTION

Various embodiments of the disclosure are discussed in detail below. While specific implementations are discussed,

it should be understood that this is done for illustration purposes only. A person skilled in the relevant art will recognize that other components and configurations may be used without parting from the spirit and scope of the disclosure.

FIG. 1 depicts an isometric view of splice 100. Splice 100 may have a main body 102. Main body 102 may define a shape for and provide structure to and support for splice 100. Main body 102 may have sidewalls defining a generally "U" shaped extruded design. In some embodiments, main body 102 may be constructed utilizing bent sheet metal. Additionally, main body 102 can be formed from a uniform material. In some embodiments, the material of main body 102 and/or other features of splice 100 may have a higher material hardness than that of a rail (e.g., rail 200 as depicted in FIG. 3).

Moreover, main body 102 may have chamfers 106 on outer edges to provide ease of alignment and installation of splice 100 into a rail (e.g., rail 200 as depicted in FIG. 3). Furthermore, main body 102 may also have an abutment protrusion 104 and one or more spring flanges 110.

One or more abutment protrusions 104 can be positioned to protrude from one or more surfaces of main body 102. In some embodiments, abutment protrusion 104 is positioned substantially along a mid-plane of main body 102. Abutment protrusion 104 is operable to abut against an edge of rail 200 and provide a stopping point as splice 100 is installed into rail 200. Accordingly, abutment protrusion 104 can prevent splice 100 from being inserted too far into rail 200. It is to be understood, however, that abutment protrusion 104 can be positioned at any position with respect to main body 102 to control a desired installed position of splice 100 in rail 200.

One or more spring flanges 110 can protrude from an aperture 108 of main body 102. Spring flanges 110 can be generally co-planar to main body 102. In some embodiments, spring flanges 110 can extend at an angle away from a center of splice 100.

FIG. 2 depicts a close-up view of spring flanges 110. Spring flanges 110 may have a main flange body 112, a flange tab 114, chamfered tab edges 116, and a bonding edge 118.

Flange body 112 can be oriented substantially co-planar to main body 102, protrude inward into main body 102, or protrude outward of main body 102. Flange body 112 provides structural support to spring flanges 110, so that spring flanges 110 do not break off when in contact with rail 200.

Flange tab 114 may protrude and/or bend at an angle away from the outer surface of splice 100. Thus, flange tab 114 can angle outwardly away from a flange body 112 that is coincident to main body 102. Similarly, flange tab 114 can be coincident with a flange body 112 that protrudes outwardly away from main body 102. Flange tab 114 may have a stiffness or spring coefficient to prevent splice 100 from readily sliding or wiggling out of rail 200, but not so much stiffness to prevent the removal of a splice 100 from being removed from a rail 200 by an average human.

Flange tab 114 may have a bonding edge 118. Bonding edge 118 can be sufficiently dimensioned to pierce a coating on a rail (e.g., rail 200) upon splice 100 being forcibly inserted into the rail. In some embodiments, bonding edge 118 can be coined to have a smooth surface to prevent chafing with wires installed therein. Spring flange 110 may have a stiffness (e.g., via structural rigidity provided by flange body 112 and/or flange tab 114) to cause bonding edge 118 to pierce a coating of rail 200, such as anodization,



paint, or powder coating, in order to cause an electrical bonding path (e.g., an electrical connection). For example, the electrical bonding path provides an electrical connection to dissipate rogue electricity (e.g., from a short, a lightning strike, etc.).

Flange tab **114** may have chamfered tab edges **116** that partially define bonding edge **118**. Chamfered tab edges **116** may reduce a volume of flange tab **114** to prevent flange tab **114** from interfering with a rail that splice **100** is being installed into. Furthermore, chamfered tab edges **116** provide a smaller volume to flange tab **114** to provide an easier installation of splice **100** into a rail.

It is further contemplated that in other example embodiments not shown, flange body **112**, associated orientations of flange tab **114**, and bonding edge **118** may extend along a length of main body **102**. In that example, spring flange **110** may act as a barb, allowing splice **100** to easily be installed into rail **200**, but requiring much greater force to remove from rail **200**.

FIGS. 3-5 depict various steps of installation of splice **100** into a rail **200**. More specifically, FIG. 3 depicts an isometric view of splice **100** being positioned in front of a rail **200**. Rail **200** can have a rail body **202** that has guides **204**, inner walls **206**, fastener channel **210**, and a structural cavity **218**.

Rail body **202** provides overall structural support to rail **200**. Rail body **202** may also have a generally rectangular extruded design. It is understood, however, that rail body **202** may have a wide variety of various shapes to accommodate a splice **100** installed therein. Ends of rail body **202** may have openings (e.g., an end where there is access to cavity **208**, fastener channel **210**, and/or structural cavity **218**) to allow splice **100** to be installed therethrough.

Additionally, rail body **202** may have guides **204** that facilitate installation of splice **100** into rail **200**. As shown, guides **204** may extend inward over rail body **202**. In some embodiments, guides **204** may also protrude downwards into a cavity **208** of rail body **202** to provide lateral support and securement to splice **100** when splice **100** is installed therein. Furthermore, guides **204** may define a distance between a distal end of guides **204** and a sidewall of rail body **202**. The distance may be operable to be substantially equal to a width of a sidewall of splice **100**, such that sidewalls of main body **102** can fit into the distance, but not so loosely that there is excess lateral movement.

Inner walls **206** may be configured inside of rail body **202** to provide additional structural support to rail **200**. Additionally, inner walls **206** and rail body **202** can at least partially define cavity **208**. Furthermore, inner walls **206** and rail body **202** can be configured to define cavity **208** in any desired shape or form, such that cavity **208** can then be designed to receive splices **100** of the desired shape or form. In other words, inner walls **206** and rail body **202** can be used to design cavity **208** to accept and receive only splices **100** of the desired shape.

As will be discussed further below, rail **200** may also have a fastener channel **210**. Fastener channel **210** is operable to receive a fastener to secure rail **200** (and splice **100** installed therein) to a mounting assembly.

Structural cavity **218** can be defined by inner walls **206** and main body **202**. Structural cavities can provide reduced usage of materials, while also maintaining structural support to rail **200**. Furthermore, each rail **200** can have any number of structural cavities defined by inner walls **206** and in any shape or size as desired (e.g., FIG. 22).

FIG. 4 depicts splice **100** being partially inserted into rail **200** as a second step of the installation process. At this stage, splice **100** is partially inserted into cavity **208** of rail **200**.

Furthermore, flange tab **114** has not yet come into contact with rail **200** and splice **100** can continue sliding into rail **200** with minimal obstruction. Moreover, splice **100** can slide along guides **204** of rail **200** to facilitate precise installation of splice **100** into rail **200** and minimize undesired lateral or vertical movement.

FIG. 5 depicts an isometric view of splice **100** fully installed into an end of a rail **200**. In this example embodiment, abutment protrusion **104** is substantially coincident with and/or abutting against an end edge of rail **200**. At this step, one spring flange **110** has compressed and/or flexed towards the inward plane of splice **100**, while bonding edge **118** has engaged or is in communication with an inner surface of rail body **202**.

FIG. 6 is an end view of a splice **100** installed into a rail **200**. In this example embodiment, the second (outer) spring flange **110** is visible, and shown to protrude at an angle away from the centerline of splice and into the dimension of rail **200**. Although not shown, in some embodiments, the first (inner spring flange that is installed and abutting against an inner surface of rail **200**) spring flange **110** can have a portion (e.g., flange body **112** and/or a portion of flange tab **114**) protruding inwards into cavity **208**.

As further shown in FIG. 6, rail body **202** and inner walls **206** can define cavity **208** to have a shape similar to splice **100**. For example, inner walls **206** form a chamfer in cavity **208**, such that cavity **208** can accept splices **100** that have a similar chamfer.

Additionally, guides **204** can extend over main body **102** and inwards into cavity **208** to reduce and/or prevent lateral movement of splice **100** as splice **100** is installed in rail **200**.

As will be discussed in further detail below, rail body **202** can also have a fastener channel **210** defined by a bottom wall **212** and channel flanges **214**.

FIG. 7 depict a second rail **200** being installed onto a second end of splice **100**. After a first rail **200** is installed onto splice **100**, a second rail **200** can be installed onto splice **100**. In this example embodiment, a first end of splice **100** has already been installed into a first rail **200**, as shown in previous figures. The second rail **200** can slide onto splice **100**, while utilizing all of the above mentioned features (e.g., guides **204**, inner walls **206**, etc.).

FIG. 8 shows second rail **200** installed onto splice **100**. When both first and second rails **200** are installed on splice **100**, splice **100** is obscured from view.

It is further considered that splice **100** may fit through an opening to structural cavity **218**. As discussed above, structural cavity **218** can have a wide variety of different shapes based on inner walls **206**. Thus, structural cavity **218** can be operable to accommodate splice **100** based on a configuration of inner walls **206**.

FIG. 9 depicts an alternative embodiment of the present invention, where an external splice **300** has a main body **302** defining a cavity **306** that is wider than rail **200**. In this example embodiment, spring flanges **310** and associated features, and abutment protrusion **304** protrude inward towards the centerline of rail **200**. This allows for bonding edge **118** to scrape an outer surface of rail **200** as external splice **300** is installed. In other example embodiments not shown, external splice **300** may have inward facing protrusions that align into the fastener channel **210**.

FIG. 10 depicts an external splice **300** installed onto a first rail **200** so that abutment protrusion **104** is substantially coincident with and/or abutted against an end edge of rail **200**.

FIG. 11 depicts a second rail **200** installed onto a second end of external splice **300**. In some embodiments not shown,

external splice **300** may extend above the height of rail **200** and may have a horizontal flange that extends inward toward the centerline and over the top edge of rail **200**.

FIG. **12** depicts another example splice **100a**. As shown, splice **100a** can have flanges **110a** externally constructed on main body **102** and have features of splice **100** (e.g., main body **102**). Flanges **110a** can be attached to main body **102** by a wide variety of different methods including, but not limited to, welding, rivets, fasteners, etc. Flanges **110a** can be constructed of the same or different materials of main body **102** (e.g., metal). Additionally, flanges **110a** can have various elements with similar properties as those of spring flanges **110** of splice **100**, such as a flange body **112a**, flange tab **114a**, chamfered edges **116a**, and bonding edge **118a**. Additionally, flanges **110a** can have attachment mechanisms **120a**, such as rivets, screws, bolts, to attach onto main body **102**.

FIG. **13A** depicts another example splice **400** in an isometric view. Like splice **100**, splice **400** can have a main body **402**, abutment protrusions **404**, chamfers **406**, and spring flange **410**.

Main body **402** may define a shape for and provide structure to and support for splice **100**. Main body **402** may have sidewalls defining a generally “U” shaped extruded design. Moreover, main body **402** may have chamfers **406** on outer edges to provide ease of alignment and installation of splice **400** into a rail (e.g., rail **200** as depicted in FIG. **16**). Furthermore, main body **402** may also have an abutment protrusion **404** and one or more spring flanges **410**. In some embodiments, an interior surface and/or edges of main body **102** can be coined to be rounded, so that materials inside of the main body **402** (e.g., wires) will not chafe against burrs.

One or more abutment protrusions **404** can be positioned to protrude from one or more surfaces of main body **402**. In some embodiments, abutment protrusion **404** is positioned substantially along a mid-plane of main body **402**. Abutment protrusion **404** is operable to abut against an edge of rail **200** and provide a stopping point as splice **400** is installed into rail **200**. Accordingly, abutment protrusion **404** can prevent splice **400** from being inserted too far into rail **200**. It is to be understood, however, that abutment protrusion **104** can be positioned at any position with respect to main body **402** to control a desired installed position of splice **400** in rail **200**.

One or more spring flanges **410** can protrude from an aperture **408** of main body **402**. Spring flanges **410** can extend at an angle inward from main body **402**. In some embodiments, spring flanges **410** can be generally co-planar with a surface of main body **402** and/or extend at an angle away from a center of splice **400**.

Spring flanges **410** can similarly have a flange body **412** and a flange tab **414**. In some embodiments, flange body **412** may have a narrower width compared to flange tab **414**. When flange body **412** is narrower than flange tab **414**, flange body **412** provides additional flexibility to allow spring flange **410** to be forced inwards towards a center of splice **400** to accommodate and abut against a surface of rail **200**.

Flange tab **414** may extend substantially parallel from flange body **412**. Flange tab **414** may have a stiffness or spring coefficient to prevent splice **400** from readily sliding or wiggling out of rail **200**, but not so much stiffness to prevent the removal of splice **400** from being removed from a rail **200** by an average human.

FIG. **13B** depicts an end view of splice **400**. As shown, flange tab **414** may have a bonding edge **118**. Bonding edge **118** can extend beyond a bottom end of main body **402**.

Additionally, bonding edge **118** can be sufficiently dimensioned to pierce a coating on a rail (e.g., rail **200**) upon splice **100** being forcibly inserted into the rail. Spring flange **110** may have a stiffness (e.g., via structural rigidity provided by flange body **112** and/or flange tab **114**) to cause bonding edge **118** to pierce a coating of rail **200**, such as anodization, paint, or powder coating, in order to cause an electrical bonding path.

FIG. **14** illustrates a perspective view of splice **400**. As shown, main body **402** may have additional apertures **408** near abutment protrusion **404**. Apertures **408** can be positioned through main body **402** to reduce a total amount of material used, while also maintaining structural integrity of main body **402**.

FIG. **15** illustrates a top view of splice **400**. As shown, flange tab **414** may have chamfered tab edges **416** that partially define bonding edge **418**. Chamfered tab edges **416** may reduce a volume of flange tab **414** to prevent flange tab **414** from interfering with a rail that splice **400** is being installed into. Furthermore, chamfered tab edges **416** provide a smaller volume to flange tab **414** to provide an easier installation of splice **400** into a rail.

FIG. **16** illustrates an end view of splice **400** installed into a rail **200**. In this example embodiment, the second (outer) spring flange **410** is visible, and shown to protrude at an angle away from the centerline of splice and into the dimension of rail **200**. Additionally, main body **402** is secured by guides **204**.

As further shown in FIG. **16**, rail body **202** and inner walls **206** can define cavity **208** to have a shape similar to splice **400**. For example, inner walls **206** form a “U” shaped lower end in cavity **208**, such that cavity **208** can accept splices **100** that have a similar “U” shape.

FIGS. **17-19** depict various steps for installing splice **400** into rail **200**.

More specifically, FIG. **17** depicts an isometric view of splice **400** being positioned in front of a rail **200**.

FIG. **18** depicts splice **400** being partially inserted into rail **200** as a second step of the installation process. At this stage, splice **400** is partially inserted into cavity **208** of rail **200**. Furthermore, flange tab **414** has come into contact with rail **200**. For splice **400** to continue sliding into rail **200**, additional force is required to cause spring flange **410** to bend. In some implementations, a user can press spring flange **410** upwards towards a center of splice **400**. Splice **400** can then continue sliding into rail **200** with minimal obstruction. Additionally, splice **400** can slide along guides **204** of rail **200** to facilitate precise installation of splice **400** into rail **200** and minimize undesired lateral or vertical movement.

FIG. **19** depicts an isometric view of splice **400** fully installed into an end of a rail **200**. In this example embodiment, abutment protrusion **404** is substantially coincident with and/or abutting against an end edge of rail **200**. Although obscured from view, at this step, one spring flange **110** has compressed towards the inward plane of splice **400**, while bonding edge **418** has engaged with an inner surface of rail body **202**.

In all cases, spring flanges **110**, **310** may be at different heights in order to allow for a new section of the rail to be cut or scraped upon splice **100**, **300** being re-installed in a different orientation into a rail **200**. For example, a first end of a splice **100** may be installed into an end of a rail **200**, where a first spring flange **110**, **310** cuts through a coating of rail **200** at a first height. Splice **100**, **300** may then be removed and spun 180 degrees so that a second end of splice **100**, **300** is aligned with the same end of rail **200**. Upon installation of the second end of splice **100**, **300** into rail **200**,

the second spring flange **110**, **310** will cut through the coating of rail **200** at a different height.

Splice **100**, **300** may be made of an aluminum with a higher hardness value than aluminum used in rail **200** to cause bonding edge **118** to pierce an anodization layer. Splice **100** may be also be a wide variety of other materials, including but not limited to stainless steel, aluminum, etc. In other example embodiments, bonding flange may be a stainless steel pin press-fit into the side wall of splice **100**. Splice **100** may transfer an adequate moment force from a first rail **200** to a second rail **200** to meet a desired load condition. Splice **100** or external splice **300** may have a substantially similar mechanical properties to transfer a moment across to rail sections, or it may have lower mechanical properties than rail **200**.

FIG. **20** illustrates an end view of a rail **200** and a fastener **500**. Fastener **500** can have a threaded length **502**, a shank **504**, and a head **510**.

Threaded length **502** is operable to receive objects, such as a mounting assembly or plate. Threaded length **502** can then secure the objects by receiving a female threaded object, such as a nut.

Shank **504** provide structural stability to fastener **500**. Shank **504** may be of a similar width or diameter as threaded length **502**.

In some embodiments, fastener **500** may be a T-shaped screw, such that head **510** defines a general T-shape for fastener **500**. More specifically, head **510** may have a concave face that is defined by distal ends **512** of head **510** angling towards shank **504** and thread length **502**. It is further considered that both a top face (e.g., surface away from shank **504**) and a bottom face (e.g., surface nearest to shank **504**) may be similarly angled. In other words, the top face may also have distal ends angled down towards shank **504**. In some embodiments, distal ends **512** may also be tapered, such that distal ends **512** are thinner than a main portion of head **510**.

FIG. **21** illustrates a perspective view of rail **200** and fastener **500**. Head **510** of fastener **500** may have angled edges **514**, chamfered corners **516**, and ridges **518**.

Angled edges **514** provide an elongated length to head **510**, so that head **510** can fill a substantial portion of fastener channel **210** when head **510** is turned to have the length vertical with respect to fastener channel **210**. Additionally, angled edges **514** facilitate angular rotation about an axis defined by threaded length **502**. Similarly, chamfered corners **516** facilitate rotation of head **510** about the axis defined by threaded length **502**. Ridges **518** are operable to prevent excess rotation of head **510** when head **510** is installed in fastener channel **210**.

FIGS. **22-25** illustrate various steps for installing fastener **500** into rail **200**.

FIG. **22** illustrates fastener **500** oriented in front of the rail **200**, with the length of the fastener **500** substantially parallel with an opening **216** of fastener channel **210**. More specifically, opening **216** can be defined by bottom wall **212** and channel flanges **214**. Bottom wall **212** may similarly have a channel flange **214** that extends upwards therefrom. Channel flanges **214** can extend inwards around fastener channel **210** to define opening **216**. In some embodiments, channel flanges **214** may also extend inwards towards a center of rail **200**, such that distal ends of channel flanges **214** are further inwards than portions of rail body **202** that they extend from.

In FIG. **23**, head **510** has passed through opening **216** of fastener channel **210**, with the head **510** fully into fastener channel **210**.

FIG. **24** depicts fastener **500** partially turned along the axis defined along threaded length **502**. Here, head **510** is angled to avoid interference with the inner wall **206**. As shown, inner wall **206** may have a general “C” shape similar to head **510**. Likewise, the “C” shape of inner wall **206** has space to allow for a thicker central portion of the head **510** to fit inside fastener channel **210** and slanted areas to accommodate angled distal ends **512**. Furthermore, ridges **518** can interfere with channel flanges **214** to prevent undesired rotation of fastener **500**.

FIG. **25** depicts fastener **500** turned so that distal ends **512** of the head **510** are substantially coincident with inner walls **206** and channel flanges **214** of the fastener channel **210**. In this position, head **510** is of a substantially similar shape as fastener channel **210**. More specifically, head **510** has a substantially similar shape as a shape defined by inner walls **206** and channel flanges **214**. Thus, distal ends **512** are substantially parallel with the some inner walls **206** and channel flanges **214**. Furthermore, in some embodiments, inner walls **206** can curve or have angles that cause a curvature greater than a thickness of head **510**. For example, inner wall **206a** forms a concave wall that curves towards fastener channel **210** at a sharper angle than the angle of distal ends **512** to head **510**. Thus, the defined fastener channel **210** may be operable to only accept specific fastener heads (e.g., head **510**).

FIG. **26** depicts an end view of the rail **200**, fastener **500**, mount **600**, and nut **602**. Nut **602** is threadably engaged with threaded length **502** to compress the rail **200** to mount **600**. Head **510** interfaces with channel flanges **214** as nut **602** is threadably engaged onto threaded length **502**.

FIG. **27** depicts a bottom view of fastener **500**. FIG. **27** provides a better view of angled edges **514** and chamfered corners **516**. As discussed above, angled edges **514** provide an elongated length to head **510**, so that head **510** can fill a substantial portion of fastener channel **210** when head **510** is turned to have the length vertical with respect to fastener channel **210**. Additionally, angled edges **514** facilitate angular rotation about an axis defined by threaded length **502**. Similarly, chamfered corners **516** facilitate rotation of head **510** about the axis defined by threaded length **502**. Ridges **518** are operable to prevent excess rotation of head **510** when head **510** is installed in fastener channel **210**.

The various embodiments described above are provided by way of illustration only and should not be construed to limit the scope of the disclosure. Those skilled in the art will readily recognize various modifications and changes that may be made to the principles described herein without following the example embodiments and applications illustrated and described herein, and without departing from the spirit and scope of the disclosure.

What is claimed is:

1. A splice comprising:

a first sidewall;

a second sidewall, the first and second sidewalls forming a main body that is substantially “U”-shaped; and at least one flange extending from the first sidewall, the at least one flange having a bonding edge with a higher material hardness than a coating disposed on a rail, wherein the bonding edge of the at least one flange is operable to cut into a coating of the rail and form an electrical connection between the rail and the splice.

2. The splice of claim 1, wherein the at least one flange is bent outwardly beyond a surface of the first sidewall.

3. The splice of claim 1, wherein a first portion of the at least one flange is in a same plane as a surface of the first

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sidewall, and a second portion of the at least one flange extends from and beyond the surface of the first sidewall.

4. The splice of claim 1, wherein the bonding edge of the at least one flange is angled.

5. The splice of claim 1, wherein the bonding edge of the at least one flange has a smooth surface.

6. The splice of claim 1, further comprising:

an abutment protrusion extending outwardly from the splice, wherein the abutment protrusion and the splice are operable to abut against an end of the rail to prevent the splice from fully entering the rail.

7. The splice of claim 1, wherein the splice is formed from a uniform material.

8. The splice of claim 1, wherein distal edges of the first or the second sidewall are chamfered.

9. The splice of claim 1, wherein the at least one flange extends beyond a bottom surface of the main body, the at least one flange operable to flex when in communication with a surface of the rail.

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10. The splice of claim 1, wherein the at least one flange is constructed separately from the splice and attached onto the splice.

11. An assembly comprising:

a rail; and

a splice, the splice having:

a main body;

a first sidewall;

a second sidewall, the first and second sidewalls forming a main body that is substantially "U" shaped; and

one or more flanges extending from the first sidewall, the one or more flanges having a bonding edge with a higher material hardness than a coating disposed on the rail, wherein the bonding edge of the one or more flanges are operable to cut into a coating of the rail and form an electrical connection between the rail and the splice.

12. The assembly of claim 11, wherein the rail has guides along a length of a rail body, the guides extending over and into the opening of the rail.

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